REPORT RESUMES

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TEACHING BEGINNING READING TO HEARING IMPAIRED CHILDREN, USING A VISUAL METHOD AND TEACHING MACHINES. FINAL REPORT.

BY- KARLSEN, BJORN
MINNESOTA UNIV., MINNEAPOLIS

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DESCRIPTORS- *PROGRAMED INSTRUCTION, *READING INSTRUCTION, BEGINNING READING, *AURALLY HANDICAPPED, *AUTOINSTRUCTIONAL PROGRAMS, CHILDREN, DEAF, HARD OF HEARING, PROGRAMED MATERIALS, SPECIAL EDUCATION, TEACHING MACHINES, SEQUENTIAL PROGRAMS, *EXCEPTIONAL CHILD RESEARCH, STANFORD ACHIEVEMENT TEST, HONEYWELL UNIVERSITY OF MINNESOTA INSTRUCTIONAL DEVICE, HUMID,

AN AUTOMATED INSTRUCTIONAL SYSTEM WAS DEVELOPED TO TEACH BEGINNING READING TO HEARING IMPAIRED CHILDREN USING A NON-ORAL METHOD. INSTRUCTION WAS DONE WITH VISUAL PRESENTATION USING 35MM SLIDES ON A REAR PROJECTION SCREEN. THIS TEACHING MACHINE, THE HONEYWELL UNIVERSITY OF MINNESOTA INSTRUCTIONAL DEVICE (HUMID) WAS CONSTRUCTED WITH AN AUTOMATIC DATA RECORDER AND PRINTOUT DEVICE. THE FIRST OF THREE STUDIES DISCOVERED THAT INSTRUMENTATION AND PROGRAMING NEEDED TO BE IMPROVED. TWO PRELIMINARY STUDIES WERE CONDUCTED. THE THIRD STUDY INVOLVED ONE EXPERIMENTAL GROUP OF 10 FIRST-GRADERS AND ONE EXPERIMENTAL GROUP OF TEN 9 AND 10 YEAR OLDS ENROLLED IN CLASSES FOR THE DEAF AND HARD OF HEARING. CONTROL GROUPS WERE MATCHED FOR IQ, AGE, SEX, HEARING AND LANGUAGE PERFORMANCE. OVER A PERIOD OF 35 DAYS, 34 PROGRAMS WERE TAUGHT TO THE EXPERIMENTAL GROUPS. TESTING DID NOT REVEAL ANY STATISTICALLY SIGNIFICANT DIFFERENCES BETWEEN THE TWO EXPERIMENTAL GROUPS, ALTHOUGH THE OLDER GROUP PERFORMED CONSISTENTLY BETTER THAN THE YOUNGER GROUP. ON THE HUMID POST-TEST, THE FIRST-GRADERS PERFORMED SIGNIFICANTLY BETTER (AT THE .01 LEVEL) THAN THEIR CONTROL GROUP. THE OLDER GROUP ALSO PERFORMED BETTER THAN ITS CONTROL GROUP, ALTHOUGH THE DIFFERENCE WAS NOT STATISTICALLY SIGNIFICANT. ON THE STANFORD ACHIEVEMENT TEST SUBTESTS OF WORD MEANING AND PARAGRAPH MEANING GIVEN TO ALL FOUR GROUPS, ONLY THE YOUNGER GROUP SURPASSED THEIR CONTROLS AT A LEVEL WHICH APPROACHED SIGNIFICANCE. THERE WERE NO STATISTICALLY SIGNIFICANT DIFFERENCES BETWEEN THE OLDER EXPERIMENTAL AND CONTROL GROUPS. ALTHOUGH AN AUTOMATED SYSTEM OF NON-ORAL READING INSTRUCTION CAN BE DEVELOPED SUCCESSFULLY, IT WOULD INVOLVE A TREMENDOUS AMOUNT OF PROGRAMING. THE HUMID STAFF ESTIMATES THAT TO BRING DEAF CHILDREN FROM BEGINNING READING TO FOURTH GRADE READING WOULD REQUIRE MORE THAN 800 PROGRAMS OF 30 TO 40 FRAMES EACH AND MUST ALSO BE ACCOMPANIED BY A SYSTEMATIC PROGRAM OF LANGUAGE DEVELOPMENT. FIVE STUDIES WERE CARRIED OUT WITHIN THIS PROJECT BY GRADUATE STUDENTS. THE MAJOR FINDING WAS THAT DATA ON THE RESPONSE DELAYS HAS LIMITED USEFULNESS WITH THIS METHOD OF TEACHING READING. PROGRAMING TECHNIQUES, CONTENT OF PROGRAMS, AND INFORMATION ON THE TECHNICAL DEVELOPMENT OF HUMID ARE PRESENTED. REFERENCE LIST CITES 34 ITEMS. (MW)

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FINAL REPORT
Project No. 1204
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Teaching Beginning Reading To Hearing Impaired Children, Using a Visual Method and Teaching Machines

AUGUST, 1966

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Office of Education • Bureau of Research

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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TEACHING BEGINNING READING TO HEARING IMPAIRED CHILDREN, USING A VISUAL METHOD AND TEACHING MACHINES

Project No. 1204
Grant No. OE-7-33-0400-230

Bjorn Karlsen, Ph. D.

August, 1966

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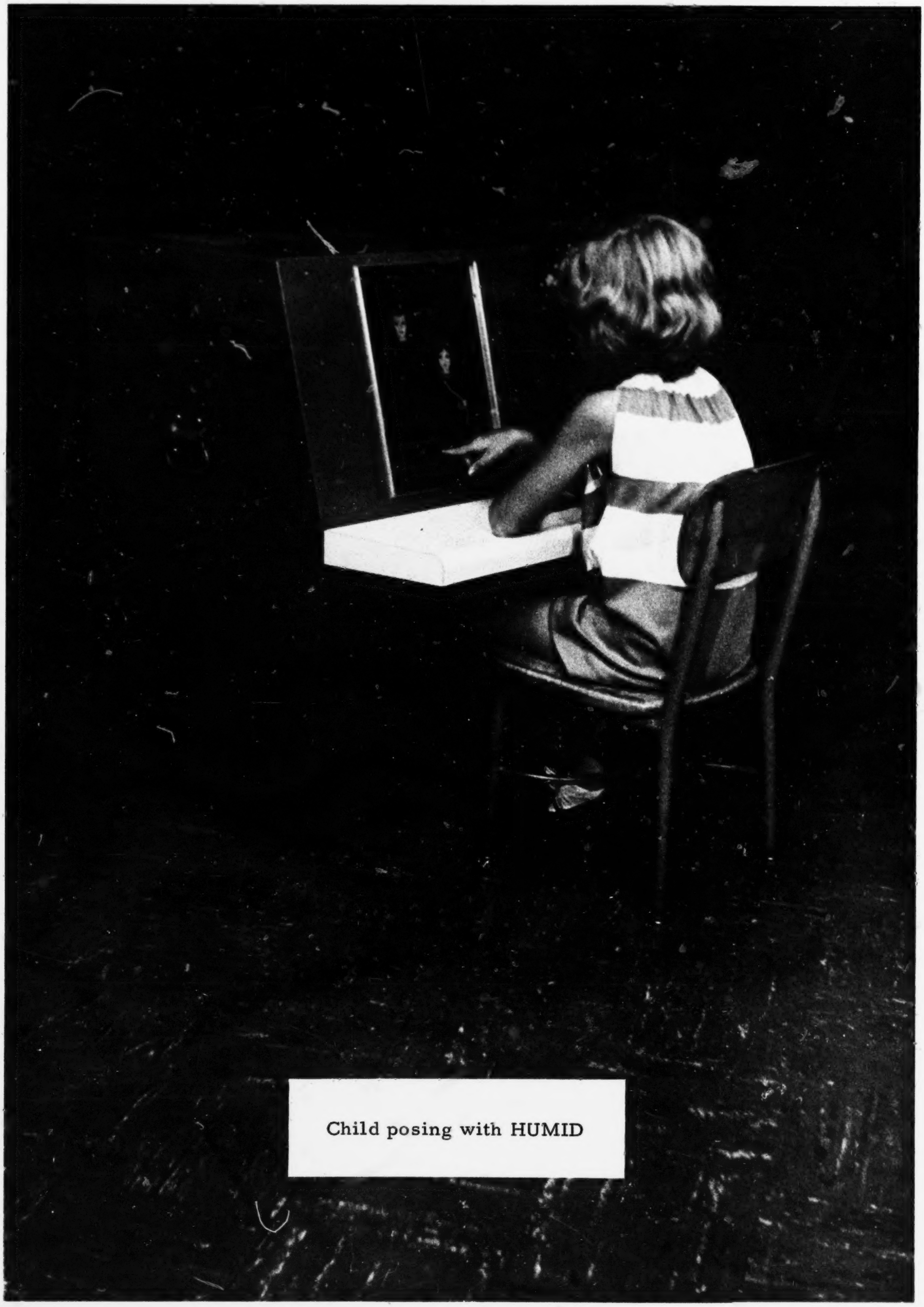
University of Minnesota
Minneapolis, Minnesota



Child posing with HUMID

ACKNOWLEDGMENTS

It is impossible to acknowledge everybody who contributed to the thinking which went into the present project, but an attempt will be made here to recognize some of the people who participated rather directly in the daily problems of Project HUMID.

The credit for the development of hardware belongs to Honeywell, Inc., whose engineers, under the general direction of Hugo Schuck, were able to translate psychological and educational principles into electronics. The software was developed by many research associates and assistants: Howard Bird, Beatrice Moosally, Barbara Wasson, Joanne Protheroe and Virginia Christenson; the last two also did extensive work on preparing the final report. Illustrator for the project was Mrs. Carvel Lee, and Ed Goldbarg was the project's photographer. These people had two common characteristics: A willingness to perceive their own work in relationship to the project as a whole, and a strong desire to produce something of extremely high quality.

In the initial phases of the project many people helped think through the ideas which were tried out and the many more ideas which were rejected. Mrs. Alice Streng was an inspiring consultant, and colleagues who helped thrash over problems included Maynard Reynolds, Rollie Houchins, Bruce Balow, and many others.

The various studies could not have been made without the assistance of the Minneapolis Hearing Society, St. Paul Public Schools and the Minneapolis Public Schools with Donald Ravel and Miss Alice Monahan.

But it was the deaf youngsters who kept us all going. The ease with which they took to our machines and their eagerness to learn to read by this approach provided us with the positive social reinforcement which sustained our enthusiasm.

Bjorn Karlsen

TABLE OF CONTENTS

ACKNOWLEDGMENTS

LIST OF TABLES AND FIGURES

CHAPTER PAGE

I BACKGROUND AND RATIONALE 1

History of the Project 1
Rationale of the Project 1
Objectives 4

II TECHNICAL DEVELOPMENT 8

Teaching Device 9
Photographic Problems 15
Letters and Illustrations 17
Color Coding 19
Word File 23
Programming 25

III EXPERIMENTAL RESULTS 34

First Study 35
Second Study 39
Third Study 46
Student Research 62

IV DISCUSSIONS, CONCLUSIONS AND IMPLICATIONS 70

V SUMMARY 73

VI REFERENCES 76

VII APPENDICES A-1

Programming Techniques and Objectives for the First Study A-1
Programming Techniques and Objectives for the Second Study B-1
Programming Techniques and Objectives for the Third Study C-1
Listing and Description of Illustrations for the Programs in Set 3 . . . . D-1
Sample Pages from HUMID Posttest E-1

LIST OF TABLES AND FIGURES

TABLE PAGE

1 Silent Reading Achievement of Deaf Pupils Compared to Grade Equivalent of Hearning Norms 2

2 HUMID Color Code 20

3 Description of Subjects: Study 2 40

4 Response Latencies During Training: Study 2 42

5 Mean Response Latencies for Programs 5 and 9: Study 2 43

6 Performance on the Posttest: Study 2 45

7 Description of Group I-Experimental: Study 3 47

8 Description of Subjects in Group I- Control: Study 3. 48

9 Description of Group II-Experimental: Study 3 49

10 Description of Group II-Control: Study 3 50

11 Summary of Descriptive Data of All Four Groups: Study 3 51

12 Total Number of Programs Completed by Subjects: Study 3 53

13 Total Number Errors Made by Subjects - Program 2 - 33: Study 3 54

14 Average Number of Errors Made Per Program 54

15 Total Errors on Trial 1 of Each Program: Study 3 . . 55

16 Average Number of Errors Per Program on Trial 1 of Each Program: Study 3 56

17 Group Data from the Programs of the Third Study . . . 56

18 Subsample Results on Latency: Study 3 57

19 Performance on Humid Posttest: Study 3 58

TABLE PAGE

20 Performance on the Stanford Achievement Test - Word Reading: Study 3 59

21 Performance on Stanford Achievement Test - Paragraph Meaning: Study 3 60

22 Summary of Posttest Data 61

FIGURE PAGE

1 The Teaching Machine HUMID I 9

2 Child Seated at HUMID II 11

3 HUMID II, Control Panel 13

4 Interior of HUMID II 13

5 HUMID II Recorder 14

6 Sample Tape from HUMID II Recorder 14

7 Photographic Stand 16

8 Sample Slide 18

9 Sample Keysort Card from Project HUMID 24

10 Frame by Frame Analysis of Program 6 28

11 Standardized Instructions for HUMID Program 1 35

12 Face of HUMID I Teaching Machine 38

CHAPTER I

BACKGROUND AND RATIONALE

History of the Project

Over the years many educators have had the idea of teaching reading to deaf children with some sort of non-oral method. Two entire teaching systems, including instructional materials have been devised: Gates and Thompson worked out their system in the early 1920's, and McDade developed his non-oral reading method in the 1930's. Only the former system was designed specifically for use with the deaf. Neither system is being used to any large extent at the present time. The main reason for the lack of current usage, despite convincing evidence that they were effective methods, appears to be the large bulk of material which is required and the very extensive problem of keeping track of all the printed material involved in these instructional systems. With the advent of instructional technology it would appear that one could develop a non-oral system where the retrieval of instructional material is done electronically. The current study is such an attempt.

After a preliminary review of past research and currently available technology, the principal investigator obtained a planning grant from the University of Minnesota Graduate School in 1963. At that time the design of a special machine for use with deaf children was initiated and one pilot study was carried out, so that when the current grant was awarded January 1, 1964, this project which later became known as Project HUMID (Honeywell University of Minnesota Instructional Device) was already underway. The research project concentrated on the study of an automated instructional system with deaf children, although a great deal of effort was actually spent solving numerous technical problems. The present report will review the many technical aspects of developing an instructional system for use with deaf children, as well as the results of several studies, using this system with deaf children.

Rationale of the Project

The research reported in this study deals with the problem of teaching reading to deaf children. The fact that deaf children have difficulty learning to read is one of the facts that the available research evidence agrees upon. Goetzinger and Rousey (1959), reported the following mean reading achievement scores for a group of 60 congenitally deaf students with a mean IQ of 103 and a mean chronological age of 17-2: Reading Vocabulary 4.2 and Paragraph Meaning 4.4. More recently, Furth (1966), has reported the data on the mean reading scores of deaf children reproduced in part in Table 1.

Table 1

Silent Reading Achievement of Deaf Pupils
Compared to Grade Equivalent of Hearing Norms

Age	N	Mean Raw Score and Standard Deviation	Mean Grade Equivalent
10 1/2-11 1/2	654	12.6 (8.1)	2.7
11 1/2-12 1/2	849	14.9 (8.5)	2.8
12 1/2-13 1/2	797	17.6 (9.1)	3.1
13 1/2-14 1/2	814	18.7 (9.3)	3.3
14 1/2-15 1/2	1035	20.8 (9.3)	3.4
15 1/2-16 1/2	1075	21.6 (9.5)	3.5

These data from the Metropolitan Achievement Test are based on a comprehensive survey of deaf children. The total sample included more than half the deaf children who were in schools for the deaf. Deaf students, then, have extreme difficulty with the acquisition of reading skills and, even more basic, the linguistic skills which are necessary prerequisites to reading. This point will be discussed more extensively in a later section of this report.

The systems of beginning reading instruction for both deaf and hearing children usually employ a basal reading series. The majority of these series teach reading through a variety of skills. These skills are visual, oral, aural and kinesthetic in nature. Such a multi-sensory approach to reading not only accommodates the different learning modalities of children, but it also provides children with diverse skills which should enable them to read proficiently. However, this multi-approach may not be entirely suitable for deaf children. Gaeth (1960; 1962), found that when deaf children were taught through the senses of hearing and vision simultaneously, they learned to ignore the auditory input. This suggests that instruction in oral and aural reading skills might not be as appropriate in a reading program for deaf children as for normal hearing children.

Another aspect of basal reading instruction to consider is the lack of language experience of deaf children. Hart (1963), has stated the problem of the deaf child in the following way: "In order to derive meaning from the written symbols, one should have previous knowledge of the language patterns these written symbols represent. Deaf children, lacking this knowledge, - - -" (p 1). Deaf children do not have the well developed vocabulary and concepts of hearing children. Neither do they have an awareness of the structure of the language nor the language patterns of idioms, metaphors, similes, personifications and multiple meanings. Little is known about the way hearing children learn the structure of the English language, but it is most likely the result of several years of exposure and usage. Hearing children seem to learn incidentally many of the rules and principles of language through hearing and talking. Deaf children do not have these experiences. While basal reader series are controlled for vocabulary, they are not controlled for concepts, multiple meanings, language structure, or language patterns. Although this is of little consequence to the hearing child, it is of such major consequence to the deaf child as to make basal reading material entirely inappropriate.

From the above discussion it seems evident that a methodology entirely different from the current approach is needed in teaching deaf children to read. Looking at the available research there is evidence which points toward a more promising approach. The doctoral study by Thompson (1927), which was finally published in 1963 (Thompson, 1963), in Exceptional Children, reported the results of a study at the Institution for the Improvement of Instruction of Deaf Mutes, New York City, (now the Lexington School for the Deaf). This study demonstrated that the use of special materials and a non-oral approach to teaching reading produced significantly better results with deaf children than the conventional method of reading instruction at that time. Buswell (1947), using McDade's method of non-oral reading instruction with hearing children, demonstrated that this method was as efficient as other methods of reading instruction used at that time. Research thus indicates that normal children can learn to read when the mode of instruction is entirely visual, and that such an approach appears exceptionally well suited to deaf children as it capitalizes upon the unimpaired sense rather than the impaired sense as the major learning modality.

A teaching technique that lends itself well to a visual mode of presentation is programmed instruction. In programming, the material to be presented to the learner is broken down into a number of small steps. The speed with which new material is presented to the learner is determined by his past experience with it: the slower he learns, the more slowly he will progress. The material is programmed in a sequence which proceeds from simple to complex, where success at one step allows the learner to proceed to progressively more complex material. Programmed instruction is, then, apparently well suited to a method of reading instruction where the systematic control of concepts, language structure, and language patterns is necessary. With this method of instruction it is also possible to provide many repetitions in slightly varying or identical forms of any portion of the material to be learned. Relating this to the teaching of reading to deaf children implies that difficult language patterns of multiple meanings, idioms, similes, etc., may be presented in a variety of contexts and in extensive exposure. Two studies published in the Volta Review (Falconer 1960), and (Fehr 1962), have investigated the use of programmed learning with deaf children. Both studies confirmed that programmed learning can be a successful teaching technique with deaf children.

Another aspect of reading which causes great difficulty for all children is the phonetic inconsistency of the English language. For the hearing child, who has already developed speech and for the deaf child who is concurrently developing speech and reading, the lack of consistency between letters and sounds causes many problems. The teaching of phonic rules alleviates this difficulty of inconsistency to some extent, however, these phonic rules have many exceptions. Clymer (1963) has pointed out that relatively few rules hold true more than 50 per cent of the time. Recognizing this inconsistency, linguists have categorized the sounds of the English language into 43 distinct phonemes which are represented by the 26 letters of the Roman alphabet. Some educators suggest an approach to reading where these phonemes are spelled consistently. These programs, although relatively new are showing good results. One such program (Downing, 1962), describes the Initial Teaching Alphabet and reports on the early experiences and results with this method in British schools.

Objectives

One could say that the HUMID method differs from the basal reader approach in the extent to which things are controlled. While there is vocabulary control in a basal reader, it means only that a given number of words are presented at a given level and a certain number of repetitions are being provided for. There is no control of multiple meanings of these word, nor of language structures or idiomatic expressions. For the normal hearing child such an approach is probably acceptable, since, as Strickland (1962), has pointed out, the children's spoken language at the time of beginning reading instruction is so much more complex than the language in their readers that it makes little difference. Her data also gives ample evidence that language structures are not controlled in basal readers.

The system of teaching which evolved in this project was one which eventually concentrated upon the linguistic aspects of reading. This was done by careful control of all the aspects of the printed language. For example, each concept which was introduced in print was illustrated with a variety of illustrations and many repetitions, in an attempt to teach the children more than a simple association between word and picture. The idea that reading is more than labeling was also developed by the early introduction of sentences and language patterns into the lessons. Each time a new sentence structure or language pattern was introduced, it was presented many times in each of several possible contexts. Thus, the child responded to it many times. No new vocabulary, sentence structure, or language patterns were introduced until the child had had ample opportunity to demonstrate that he understood what had been presented up to that time.

In the initial phases, a word was typically taught by showing the word on the screen, and above the word an illustration of a specific meaning of that word. This word was also presented on one of the response panels, so that it was merely a simple matching task for the child to press the correct panel. Gradually, distractors were introduced, and eventually the word itself was removed from below the illustration. Although numerous illustrations were used to develop a given concept, care was taken that only one meaning of a given word was taught at one time.

The child responds by pressing one of several panels, each one of which corresponds to a line of print on a teaching machine. When the panel is pressed it is transilluminated by a green light, and a few seconds later a new frame appears if the child has made a correct response. The response panel is transilluminated by a red light and the same frame appears if the child has made an incorrect response. Thus, a child has immediate knowledge of results. The child's progress in this type of reading instruction can be judged by his success with the programmed material.

An attempt was made to provide for phonetic consistency by means of a color coding system which was also developed within this project. Such a system would be useful only if an oral language program was connected with this system. Since this was not the case, the color code was merely present. No attempt was made to teach his code deliberately.

It was initially also attempted to experiment with the use of three-dimensional print, but the technical difficulties were rather extreme. This issue was resolved by one of the research assistants, Howard Bird, who made this issue the subject of his doctoral dissertation, the results of which are summarized in a later section of this report.

This project had several major objectives. These had been outlined initially, but since they were interdependent and sequential in nature, some of these objectives were reformulated during the project. The two main areas of inquiry were: The development of a system of teaching beginning reading to deaf children, and the study of effect of such instruction upon the reading ability of the children.

This project attempted to answer the following questions:

1. Can an instructional system be developed for teaching reading to deaf children which is non-oral in nature, and which utilizes programming techniques?

2. What are the parameters of such a system?

3. Can an automated system sustain the interest of young, deaf children over a prolonged period of time?

4. Can an instructional device be designed and built which is suitable for deaf 5-year-olds?

5. Are there ways in which the findings from experimental psychology can be translated into this instructional system? These findings relate to dimensionality of the display, fading techniques, color coding, attention, etc.

6. Can the principles of programmed instruction be applied to the subject of reading and to young, deaf children?

7. What aspects of beginning reading instruction are unique to deaf children?

8. When deaf children spend part of their reading time with a teaching machine, how does their reading achievement compare with that of other deaf children?

9. What are the most effective ways of assessing progress in reading with machine teaching?

10. What are the unique contributions of teaching machines within a comprehensive educational program for deaf children?

During the 32 months of this research project these questions have all been answered, but with varying degrees of sophistication and confidence. On some issues one will find extensive empirical evidence, on others, the investigator has arrived at some rather definite conclusions based upon a great variety of findings, impressions, and day to day observations.

CHAPTER II

TECHNICAL DEVELOPMENT

Since the major share of the time spent by the staff of this project was taken up by a wide range of technical problems, an entire chapter will be devoted to this. It came as somewhat of a surprise that so few of the problems encountered in this project had been tackled by people in allied disciplines, or, if they had been solved, information about these solutions was not widely disseminated. A great deal of information about teaching machines is available, but the vast majority of it is only available in prototype form without any accompanying software. There were times when the project staff had the feeling of starting completely from scratch, since it was necessary to solve problems like the following:

There was not available, commerically, a camera stand which would hold a camera at a 4-5 feet height above a still layout except for a $10, 000 German import. A camera stand was eventually built.

In order to find some lower case letters for the display, inquiries were sent to all letter manufacturers who advertised in the sign makers' trade journal, finding that they produced letters in all kinds of materials, sizes, and type, but they were all upper case letters. One manufacturer made lower case letters, but the type was not appropriate. After a 3-month search the ideal letters were found; they are made in France, all sizes being in millimeters.

The Research chemists of two major paint manufacturers could not give much advice on how to "fade" a black letter into a white one through even equal steps, beyond the recommendation of, "Buy a quart of black and a quart of white and try it." Attempts at measuring paint with a veterinarian's syringe were unsuccesful, and having an art student match color with the color chips of the Munsell color charts was found to be the most satisfactory approach.

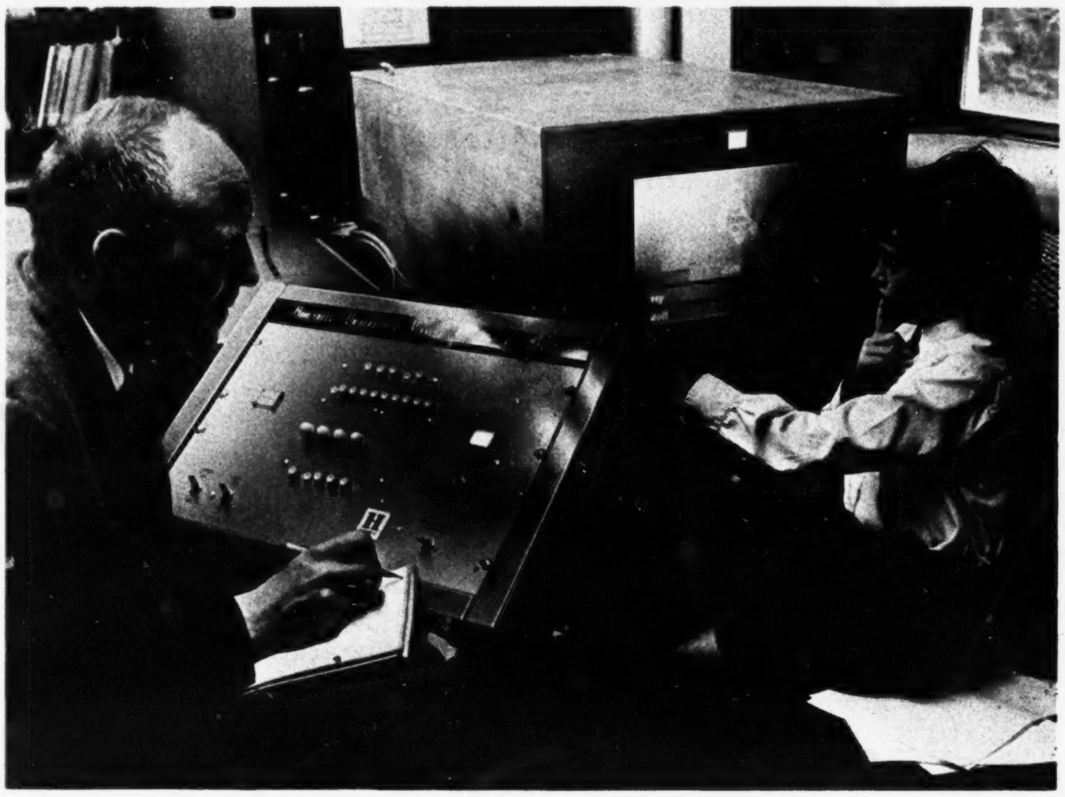
These are examples of a great variety of fundamental problems which were encountered, but which will not be discussed in this report. This chapter will, however, discuss the major problems of producing the hardware and the software which went into project HUMID.

The Teaching Device

Honeywell-University of Minnesota Instructional Device (HUMID) was initially conceived by the principal investigator (Karlsen, 1966), who submitted an "exterior design" in terms of how such a machine should function, what type of display should be involved, and what functions the various switches were to serve. This description was translated into hardware by the Military Products Division of Minneapolis-Honeywell, Inc., who constructed the first machine, HUMID I. (Figure 1) This machine was used in the first study.

Figure 1

The Teaching Machine HUMID I



HUMID I is composed of two units, an instructional unit and a control unit. The instructional unit is a plywood box, 22 inches wide, 14 inches high and 40 inches deep. Housed in the rear end of this box is a 35 mm. Sarkes-Tarzian TSP-6A Random Access Slide Projector. At the other end of the box is a "Polacote" viewing screen. Operating on the rear projection principle, slides are projected from the projector onto the screen. Above the screen is the "ready" light. This is a white light which comes on as a signal to the child that he is expected to respond. This light goes off as soon as a response is made. Four response buttons are located beside the screen. Two of these, one above the other, are located beside each of the lower corners of the screen.

The slides which are projected onto the screen are constructed so that they show a stimulus section and a response section. The top, the largest portion of the slide, contains the stimulus material. The lower part of the slide contains the possible responses. This lower part is divided into four sections. When the slide is projected, each one of these sections corresponds to one of the response buttons. Confirmation of response is accomplished with transilluminated response buttons, illuminating either green (correct) or red (incorrect) following each response of the child.

The instructional unit is placed on a low table so that a child sitting on a kindergarten chair can see the screen clearly and can reach the response buttons easily.

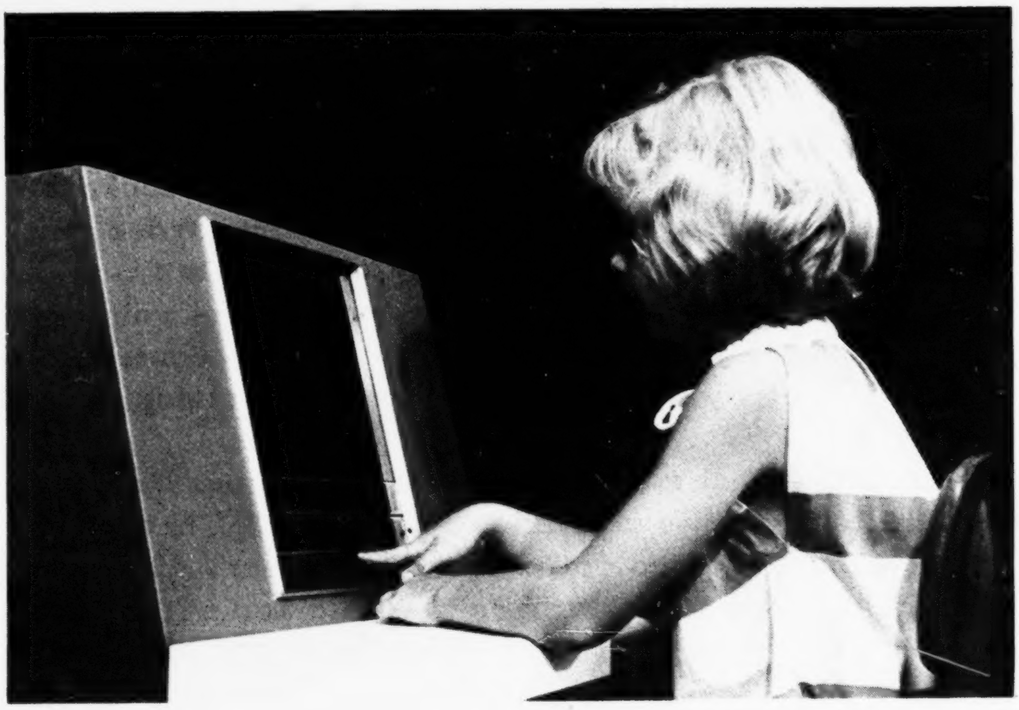
The control unit of HUMID I, contains buttons which enable the experimenter to turn off the reinforcement lights, to project the desired slide, to set the machine so that the correct response will be reinforced and to turn on the "ready" light. The child's responses are monitored on the panel by a series of lights. After each correct response the program is advanced one frame and the machine reset, while after each incorrect response the machine is reset and the child is required to make another response to the same frame.

HUMID I was the teaching machine used for the first pilot study conducted during July, 1964. During this study problems were encountered which were considered serious enough to demand some major modifications in HUMID I. The most serious problem was the general format of the frame and the mode of response. To respond to a frame, a child pressed one of two buttons in the lower right corner of the frame or one of two buttons in the lower left corner of the frame. These buttons were aligned with the response choices. This procedure was satisfactory for the two responses on the right. However, responding to the choices on the left appeared to encourage a right-to-left directionality in the children's hand and eye movement. This occurred because children reading a response in this location had to move to the left to respond with the button. Since the eye progression of mature readers is from left-to-right, the possibility of encouraging this incorrect progression was of great concern.

Also, the manual control of the machine weakened it considerably as a research tool. The time required to change slides varied, as did the duration of reinforcement accompanying each slide, and it was impossible to get an accurate measure of the latency of each response. Record keeping was also a major problem, since everything for HUMID I had to be done manually. The children had some difficulty depressing the response buttons, they were somewhat confused by the "ready" light, and many other considerations all resulted in the decision to modify HUMID I. Thus the Panel Division of Minneapolis-Honeywell, Inc. built a revised teaching machine, HUMID II, which was received in 1965. (Figure 2)

Figure 2

Child Seated at HUMID II



HUMID II is a fully automated, self-contained unit. The exterior cabinet is of molded steel with ventilation slots located on the top and bottom. Sturdy handles attached to each side of the cabinet and casters aid in maneuverability and transportability. A door in the lower back of the cabinet allows access to the interior of the machine.

The height of the machine is 34 inches, the width is 22 inches, and its greatest depth is 22 inches. A 9 inch formica covered shelf projects from the front of the machine and serves as an armrest for the subject. The screen, 13 inches high and 9 1/2 inches wide is located above the shelf and is framed in molded aluminum. The height of the shelf and the screen were determined from a table of heights of kindergarten children. The top and largest portion of the screen is the part on which the stimulus is projected. The lower part of the screen contains three horizontal panels onto which response alternatives are projected. These panels may be depressed with little effort by the subject. If the correct panel is depressed the other two panels light up in green. If an incorrect panel is depressed, that panel is illuminated in red. The rationale behind illuminating the two wrong answers when the child gives a correct answer is mainly optical, in that when a light is projected onto a rear projection screen which already has a projected image, this initial image will fade considerably. Projecting green light onto the panels containing the wrong answers would cause these answers to fade, while the correct answer stands out. When the red light is projected onto the incorrect panel, this incorrect answer will be faded, calling the child's attention to the other choices. The red and green reinforcement lights are activated by lights shining on photoelectric cells from coded answers on each slide.

On the back of the machine is a control panel with a main power switch, start and stop buttons, and on-off switches for a lockout relay override, negative reinforcement, and a data recorder unit. (Figure 3) Two timer dials are on the control panel. One is a delay of reinforcement dial which has a range from immediate reinforcement to a 15-second delay of reinforcement. The other dial controls the duration of reinforcement with a range of 0.2 to 15 seconds duration.

The interior of HUMID II contains a Kodak Carousel Projector, which had to be adapted for this machine. (Figure 4) Through the use of mirrors, the image is projected onto the screen. Two small reinforcement projectors and a timer are also located within the machine. All other electrical wiring, relays, etc. are also contained within this cabinet.

Figure 3

HUMID II, Control Panel

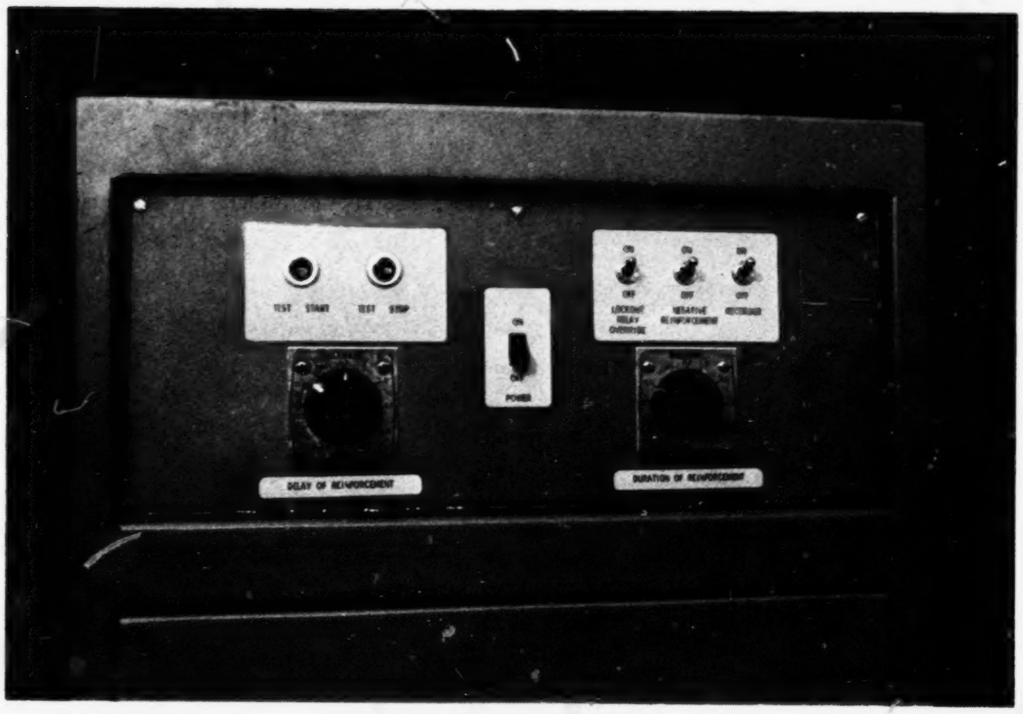
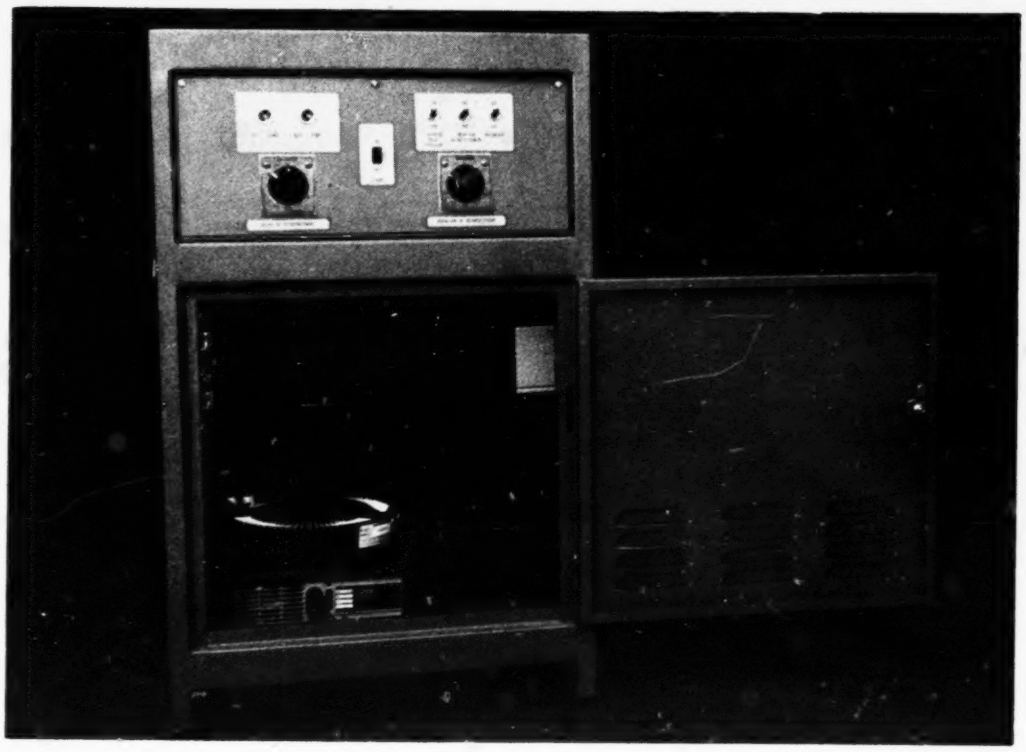

TEST START
TEST STOP
ON
OFF
POWER
ON
OFF
LOCKOUT DELAY OVERRIDE
NEGATIVE REINFORCEMENT
RECORDER
DELAY OF REINFORCEMENT
DURATION OF REINFORCEMENT

Figure 4

Interior of HUMID II



Separate from the machine is a data recorder unit, the HUMID II Recorder. (Figure 5) This unit prints out on adding machine tape a record of the subject's performance. (Figure 6) The information includes the slide number, the correct answer, the incorrect answer when it is the response made and the response time in seconds.

Figure 5

HUMID II Recorder

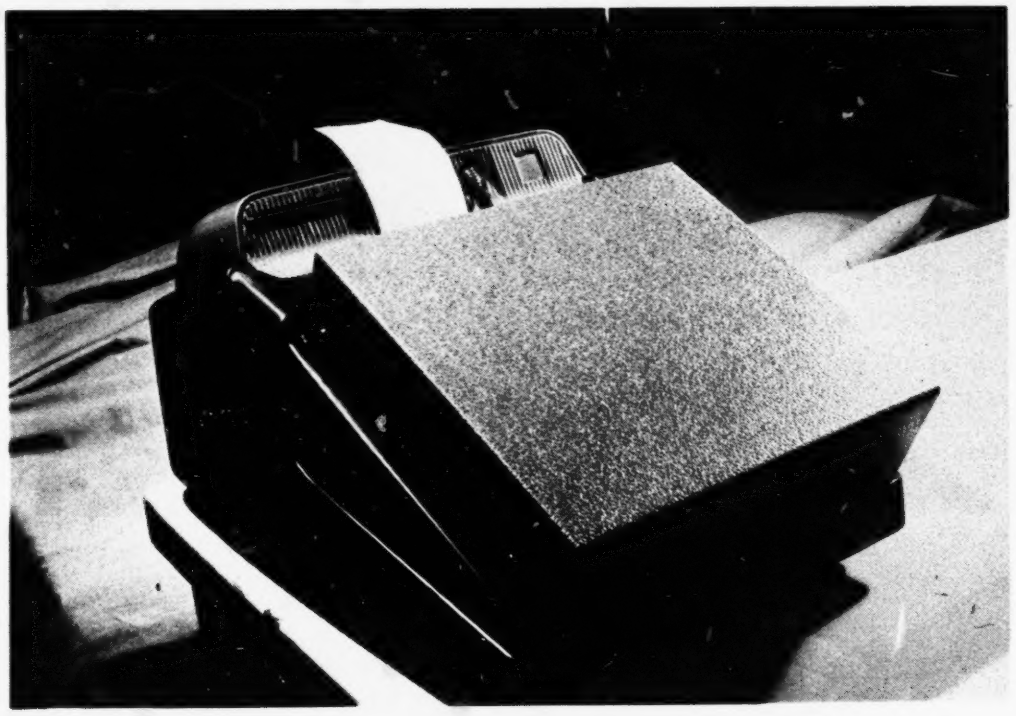


Figure 6

Sample Tape from HUMID II Recorder

```
00 A   002
01 C   004
02 BA  001*
02 B   007
03 A   010
04 B   013
05 AC  006*
05 AB  008*
05 A   006
06 C   012
```

*On the original tape the numbers and letters on this line appear in red.

Referring to Figure 6, the first two columns identify each slide by number. The third column indicates the letter corresponding to the correct response. The fourth column is used only when an incorrect response is made, the letter corresponding to the incorrect choice being indicated in this column, and the last three columns indicate the response latency in seconds. Thus the first line identifies slide 00 with the correct answer on response panel A and a response latency of two seconds. The second line identifies slide 01 with the correct answer on response panel C and a response latency of four seconds. An incorrect response was made to slide 02, and the letter corresponding to the incorrectly chosen response panel A is printed in the fourth column. The response latency was 11 seconds. Since the response was incorrect the same slide remains projected on the screen and the subject responds again. This response is identified by the same number as the incorrect response preceding it. All incorrect responses are printed on the tape in red and all correct responses are printed in black.

Photographic Problems

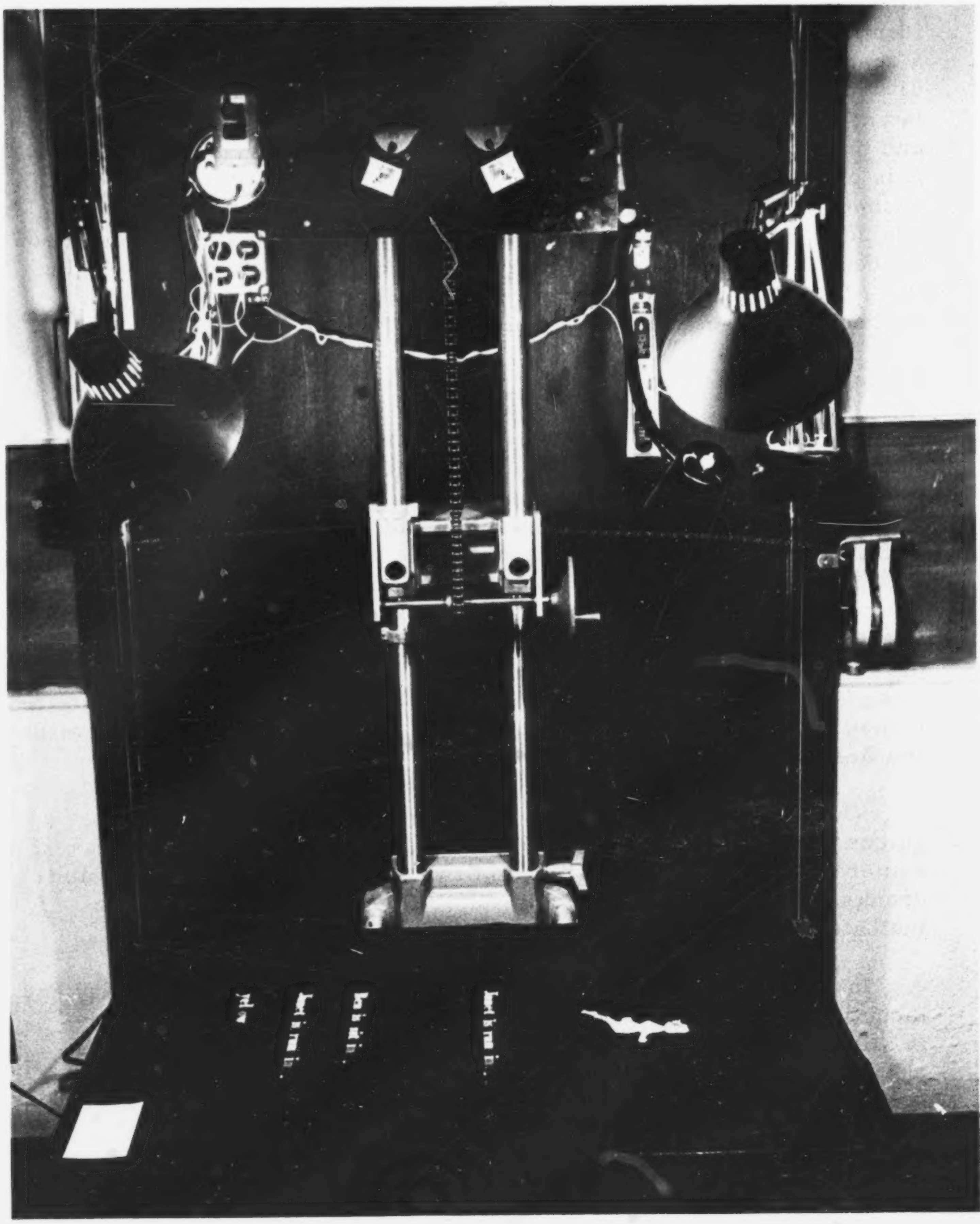
The University Photographic Laboratory originally committed themselves to produce the slides for the HUMID programs. However, this proved to be not only very expensive, but inefficient as well since the laboratory was located on a different campus and there was always a waiting period. In view of these problems it was decided to add a consultant photographer to the HUMID staff. A custom made photographic stand was built by the Scientific Apparatus Services of the University of Minnesota in order that the HUMID personnel could produce their own slides. (Figure 7) An Exacta single lens camera was given to the project by the Graduate School. This procedure turned out to be a wise move, since this equipment paid for itself after the first year of operation.

The photographic stand has an adjustable table, marked with guides to facilitate the correct lay-out of a slide. An adjustable camera plate can be moved up and down and back and forth with hand cranks. There are also two adjustable flood lights and a clock to indicate the number of hours the floodlights have been used.

In processing the film it was found that the mechanized cutting and mounting of the slides resulted in slides which varied considerably in alignment. This was a serious fault in that it is necessary to hit photoelectric cells and other targets with the slides. Thus to ensure exact alignment, the developed film is returned from the processors and cutting and mounting are done by hand. All slides are mounted in Press-O plastic mounts, made by Kaiser Products, which are not only sturdier than the cardboard mounts, but easier to use as well as less expensive.

Figure 7

Photographic Stand



During the preliminary study of this instructional system it became quite evident that the use of black print on a white background would result in the children looking at a large white surface which produced a very fatiguing glare. This problem was solved by the use of white letters on a black felt background. Later, as colored letters were introduced it became apparent that white letters tended to "bleed" and look perceptably larger than the other letters. In the final set of programs the letters were light grey (7/9 in the Munsell color code).

The black felt background yielded slides of exceptional clarity because a great many minor irregularities were absored. It had, however, a major drawback in that the shading which was to give a three-dimensional effect disappeared. After extensive experimentation it was decided to delete this feature of the project. It was the subject of a separate study.

It would appear appropriate at this point to indicate that in several studies with both deaf and normal children, the transition from the machine to black print on white paper caused no difficulty for the children. No child has ever indicated that he was aware of the color reversal between these two modes, and tests administered through both modes to the same children have revealed no differences.

One of the main principles employed in photography was that of photographing an image which was several times the size of the screen on the teaching machine. When an image is smaller than the original, all irregularities are reduced in size. Conversely, when an image is enlarged, all irregularities are also enlarged. A major reason for the clarity of the slides in this project was unquestionably the result of the application of the above principle.

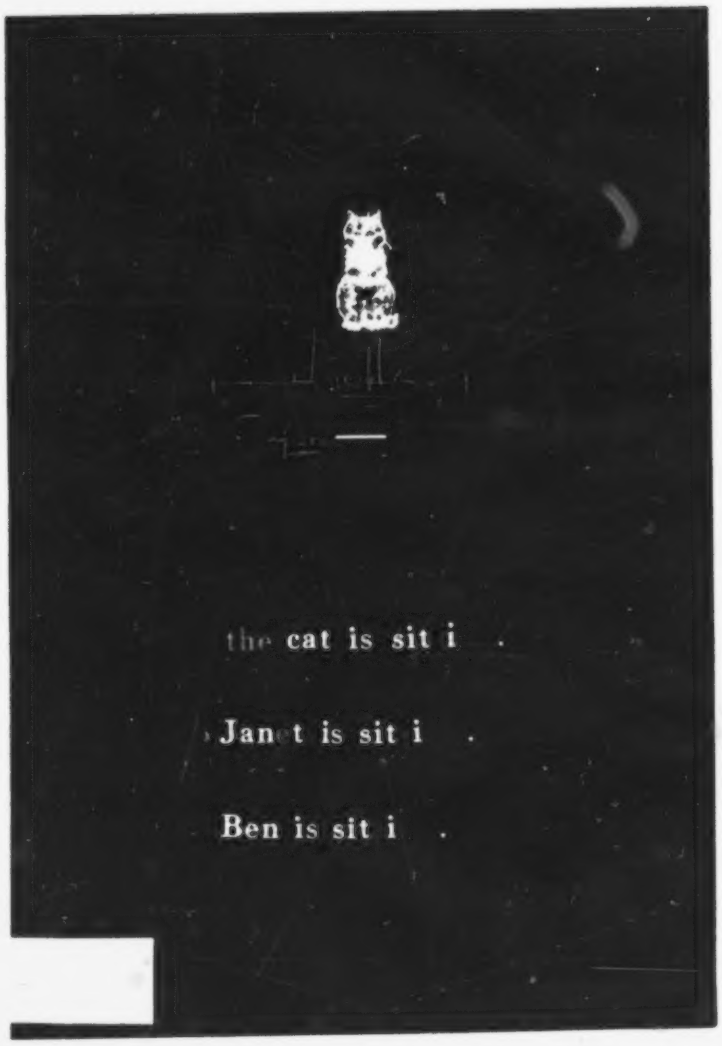
Figure 8 shows a print of a sample slide. The bottom part of each slide has white rectangular areas in one or both of the bottom corners, depending on the correct answer to that particular frame. These signals do not appear on the screen, but hit photoelectric cells below the screen inside the machine. In this way the correct answer is coded on each frame, making it possible to exchange frames and rearrange them without necessitating synchronization with a "key".

Letters and Illustrations

The three-dimensional letters used are stamped out of cork. Each letter is 2 millimeters thick, and the capital letters have a height of 16 millimeters. The type is identical to that used in beginning readers. The letters are made by Graforel Display Letters, Paris, France. They appear on the screen as about 20 point print.

Figure 8

Sample Slide



the cat is sit i .

Janet is sit i .

Ben is sit i .

Two University of Minnesota Art students were successively employed at first to make illustrations for the HUMID programs. The use of students for this proved to be too unstable, and it resulted in inconsistencies and much variation in quality. Mrs. Carvel Lee, a professional illustrator of children's books, was then hired, and she has remained with the project throughout its duration. This not only insured consistency in the illustrations, but her experience as a children's illustrator provided the project with illustrations of words and concepts for children which were of extremely high quality. This was very important inasmuch as the HUMID programs utilized the illustrations in a visual approach to the teaching of words and concepts. Many illustrations were used to develop a single concept. Illustrations were painted on tag board, cut out and placed on black felt for photographing. Occasionally it was found that an illustration which looked very good turned out rather poorly when photographed. In those rare instances it was necessary to have the illustration redone. There were a couple of illustrations in both program 1 and program 2 which the children had sufficient difficulty interpreting, consequently the illustration had to be remade. This was revealed by the frame analysis.

Color Coding

This project was initiated around 1962. At that time the field of reading instruction was beginning to feel the impact of structural linguistics. Fries (1963), published his book on Linguistics and Reading, the Bloomfield and Barnhart (1961), system of teaching reading came out, and good success was being reported with the Initial Teaching Alphabet. These approaches dealt primarily with the application of the study of phonemes, and used as a fundamental base for initial reading instruction the idea that beginning reading should start with words that were spelled with phonetic consistency. In the Bloomfield and Barnhart system this resulted in extensive reading of words which were spelled phonetically, but which might not even be understood by the average first grader. In the Initial Teaching Alphabet the problem was solved by inventing some additional letters, so that there are 43 letter symbols altogether, one for each phoneme. This necessitated having the children learn letters and cues which they later would have to unlearn.

The rationale behind a color coding system was to develop phonetic consistency by a combination of letter shapes and colors. The most common phoneme represented by a given letter was presented by means of the standard, light grey color. The variant spellings of the phonemes were represented by colored letters. This resulted in a phonetically consistent system which did not require any respelling.

The HUMID color coding is different from Word in Color (Gattegno, 1962) that the latter systems is based on every phoneme having a distinct color, while in the HUMID system color is introduced as an additional clue for only the variant spellings of the phonemes. The most commong spelling contains no color cue.

The color coding system is presented in Table 2. The letter or letters which are given a certain color are capitalized in this table. For example, the s-sound as in sat is represented by a standard grey s, but in the word has, it is represented by a yellow s. The double consonant, as in boss, is represented by the first of the two, the latter is "faded out".

consonant, as in boss, is represented by the first of the two, the latter is "faded out".

A "faded out" letter is one that is black on a black background, which makes it barely perceptible. Over a period of time this letter would go through several shades of grey, until it is eventually "faded in"; i. e. it looks like the other letters. It was the original intention to subject the color coded letters to a "fading out" process, where they would be faded through a series of shades, moving toward the basic light grey of the other letters. The Munsell Color System (1954), was used to label all the colors used in this study, so as to make it replicable.

As this project has progressed, the color coding has been re-remphasized. It is present in all programs, but it is not taught deliberately. So far, no systematic study has been made of this code. It would appear to have limited usefulness, unless it is coordinated with a total language program. It probably has its greatest usefulness for word pronunication, which is deemphasized in this project.

Table 2

HUMID Color Code

Examples of consonants and vowels requiring each particular color are capitalized.

Consonant	Grey	Blue	Green	Red	Yellow	Purple	Black
b	Bat						robBer
	roBber						
d	Dig						adD
	aDd						eDge
f	Fair						ofF
g	Get					Gem	egG
						edGe	alonG
h	Head						ecHo
j	joy						
c	Cat	Cent					
	back						
	eCho						
k	Kid						bacK
l	Let						alL
	aLl						alL
m	Met						sumMer
	sumMer						

Table 2

Continued

Consonant	Grey	Blue	Green	Red	Yellow	Purple	Black
n	Net		aNkle (ng)				inN
	iNn		aloNg				
p	Pet						dropPed
	droPped						
r	Red						corRal
	coRral						
s	Sat		leiSure	Sure	haS		bosS
	boSs		uSual		doeS		
	stateS				buSiness		
t	Till		fuTure				cig-aretTe
	cig-areTte		virTue				caTch
v	Vat						
w	Way						(of-both grey)
z	Zoo						
x	boX						
q	liQuid						
ch			CHild				
			catCH				
gh		lauGH					
sh				**SHIp**			
th					THin	THey	

Vowels	Grey	Blue	Green	Red	Yellow	Purple	Brown	Black
a	At	Any	Arm	Age, dAy	All	vAry	wAnt	heAd, eAt
	lAugh	sAid	heArt	Able, Aid	Auto	awAre		leAve
			guArd	Ate	jAw	Air		
								oAk, broAd
				rAise		beAr		beAr
e	pEt	blEw	fEw	bEef Evil	obEy	thEre	bElow	hEart

Table 2

Continued

Vowels	Grey	Blue	Green	Red	Yellow	Purple	Brown	Black
	hEad		viEw	fiEld, lEave		thEir		beEf, geEse
	friEnd			hEre, piEce		whEr-ever		honEy, hEight
	guEst			gEese, Eat Either				EyE, bouquEt brEak rhEumatism (all silent o endings omitted)
i	pIn	onIon		Ice, Item				aId, saId
	buIld			dIe, choIr heIght				frIend, suIt fIeld, pIece eIther, aIr theIr, raIse vIew
o	hOt	Owl	bOok	Old, hOpe	Off	mOve	Oven	chOir, bloOd
	knOwledge		wOlf	Own, Oak	Ought	fOod	blOod	boOk, foOd
		Out		sOul, fOe Owe	brOad	shOe		cOuld, yOu oniOn, grOup cOuntry
u	cUt		coUld	Unit	bUsy	rUle		laUgh, gUard
	coUntry		pUt	Use		groUp		gUest, bUild

Table 2

Continued

Vowels	Grey	Blue	Green	Red	Yellow	Purple	Brown	Black
				dUe		blUe		soUl
						sUit		oUt
						rheUmatism		aUto, oUght
						yoU		
y	Yes		boY		bY			daY
					tYpe			
								OF special treatment

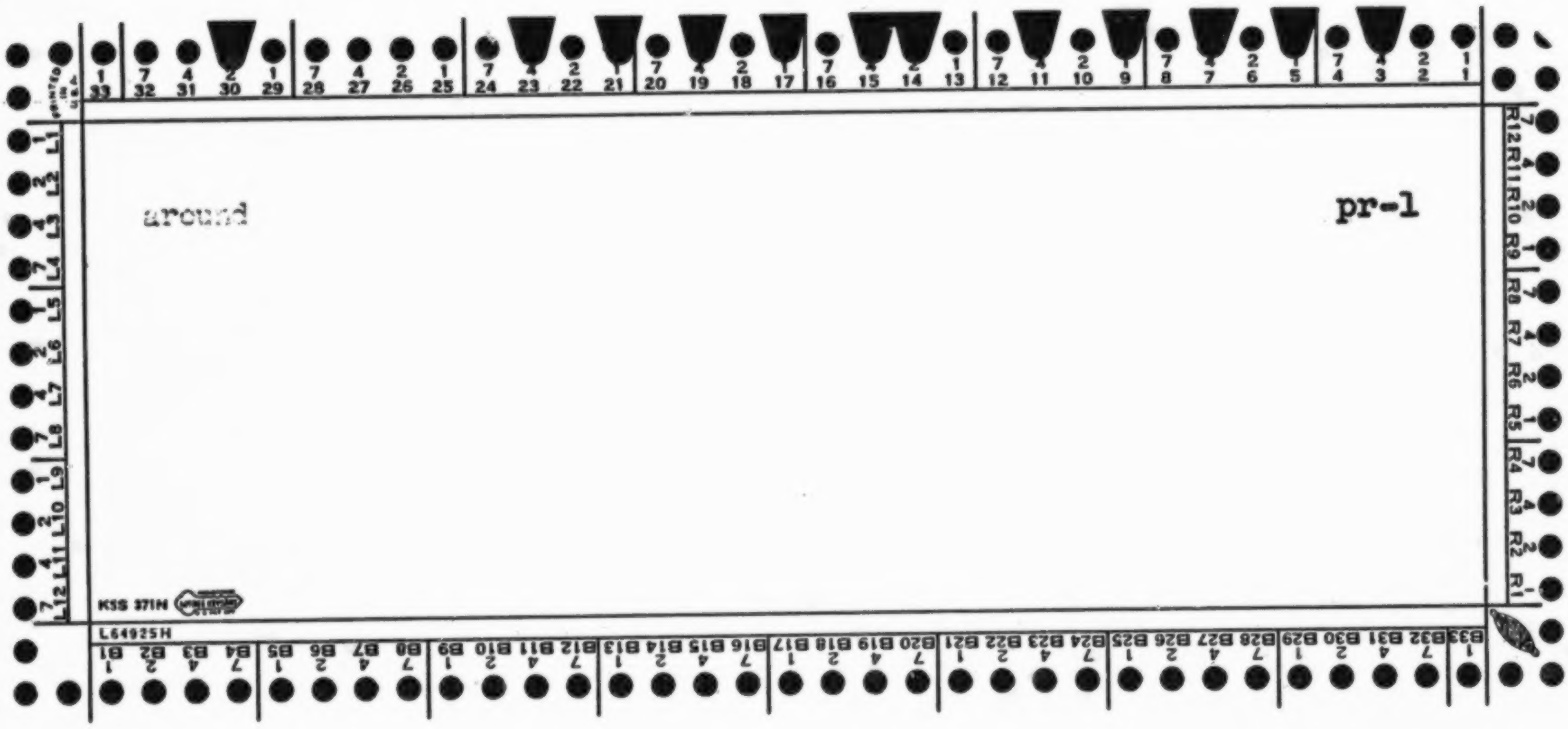
Word File

In order to coordinate the vocabulary of Project HUMID programs with the vocabulary of basal reading series for first graders, a word file was established. The words in this file were compiled from the words introduced at the primer through the third grade level in each of the basic reading series of the following publishers: Ginn and Co., Houghton Mifflin Co., Lyons and Carnahan, the McDade material by Plymouth Press, Row, Peterson and Co., Scott, Foresman and Co., and from the first thousand words at the first grade level of the following word lists: Rinsland, A Basic Vocabulary of Elementary School Children and Stone, Graded Vocabulary for Primary Reading. Approximately 3,000 words were gathered from these sources. These words were typed on McBee Keysort Cards and each word card was coded to show its level of introduction in the six basic reading series and its frequency of usage as recorded in the two basic word lists. This file was compiled as a reference for use in determining which words to introduce in which order and which words it was necessary to teach before children were ready to transfer to a specific book of a given reading series. A sample word card is shown in Figure 9.

Reading across the top of the card from left to right provides the following information on the word around:

Figure 9

Sample Keysort card from Project HUMID



1. Rinsland places the word among the 2nd 100 for grade 1 (1a2).

2. McDade does not introduce this word.

3. Houghton Mifflin introduces the word in the 1^2 reader.

4. Row, Peterson introduces the word in the 1^1 reader.

5. Scott, Foresman introduces the word in the 2^1 reader.

6. Ginn introduces the word in the 1^1 reader.

7. Lyons & Carnahan introduces the word in the primer.

8. Stone places it at the Pr-1 level.

This word-file has been used in designing the reading programs, but it has not been followed blindly. There are many concepts which normal children acquire outside their reading instruction; with deaf children however, it is necessary to introduce some of the most common objects and concepts of everyday life. Words like fork and spoon are typically not taught in the first grade, but deaf children should learn them. This is also true of other things relating to their daily lives, such as pieces of furniture, toys, food items, pieces of clothing, etc. A special reading program for the deaf would have to include such vocabulary.

Programming

Three sets of linear programs have been developed for HUMID, although many of the individual programs were revised several times. Set 1 was developed for use in HUMID 1 and was used for the first pilot study. Sets 2 and 3 were developed for use in HUMID 2 and were used in the second and third studies. As more data were gathered from each succeeding study, the programs were modified.

Set 1 consisted of 10 programs, each containing 40 to 50 frames. The first two programs taught the use of the machine with colored geometric shapes, single letters, and letter combinations as content. Each frame required the child to respond in a multiple choice situation. The number of possible choices ranged from one to four. Only one response panel was filled in the very early frames. Then a distractor (incorrect choice) was added. Finally, two and then three distractors were presented. Programs 3 and 4 presented four nouns with thirteen illustrations. Each word was first introduced with an illustration in the stimulus portion of the frame, and was matched with an identical word in one of the response panels. Distractors, up to a total of three were added gradually. Eventually, the stimulus word was replaced by a blank and the subject was required to choose a word in a response panel which went with the illustration. Again, there were no distractors in the beginning and distractors were added gradually. Using the same methods, programs 5 and 6 presented five new nouns and fifteen new illustrations as well as reviewed previously taught nouns. In addition to review, programs 7, 8 and 9 presented a conjunction, an article, one preposition and two nouns. Appendix A contains a more complete description of the first set of programs.

Set 2 was developed for the second study. Although the subjects had performed very well on the first set of programs and it was evident that a system had been developed from which these children could learn to read at a vastly accelerated rate over previous methods, it was felt that sufficient improvements could be made in the programs to warrant a complete rewriting. It appeared that the programs were too long to hold the attention of children of this age. The programs themselves were made shorter by reducing the number of frames per program from approximately 45 to about 30. Also, the maximum number of response choices per frame was reduced from four to three. Furthermore, because the subjects were finding it difficult to complete the programs successfully in a reasonable number of attempts, the amount of material (verbal content, illustrations, and techniques) presented in each program was reduced.

In set 2 the number of introductory programs was increased to three. As pictures were thought to be more intrinsically interesting than geometric shapes, the content of the first two programs was changed from geometric shapes to pictures. Standardized instructions were developed for use with the first program. The third program, in addition to reviewing the picture matching introduced in the first two programs, introduced word matching without the use of illustrations. It was felt that this would provide a transition from picture matching to matching when the stimulus word was accompanied by a picture. Besides reviewing what was taught in previous programs, the introduction of other words and concepts in the subsequent programs was as follows for set 2:

Program 4 introduced two of the nouns introduced in program 3 with eight illustrations.

Program 5 introduced two new nouns using ten new illustrations.

Program 6 introduced one verb. (In set 2 phrase and sentence reading were introduced much earlier than in set 1. It was hoped that this would help the children understand that reading is a form of communication and not just labeling of objects.)

Program 7 introduced two articles.

Program 8 introduced a verb.

Program 9 introduced a conjunction.

Program 10 introduced two sentences in one frame.

Program 11 introduced variant forms of the two previously learned verbs.

Program 12 introduced two nouns and six illustrations.

Program 13 introduced a preposition with three new illustrations.

Program 14 introduced a preposition with four new illustrations.

Program 15 was a test program. This program included two samples of each concept developed during the previous twelve programs.

A more complete description of these programs can be found in Appendix B.

During the second study observations were made which led to another complete revision of the programs. These observations indicated that the ability of deaf children to form general concepts had been vastly overrated in that these children required a large number of experiences and exposures to given objects and ideas before they were able to form general concepts. By providing the number of exposures necessary for concept development, the primary focus of the HUMID programs changed from a reading program to a more generalized comprehensive language program.

In set 3, the major revision that took place was the reduction in step size in programming concepts. Through careful study of children's responses to individual frames, it became possible to find very short steps which could be reduced to even shorter, almost imperceptible steps. At the same time the programs were held to 35 frames. Previous language experience was not taken for granted, and new concepts were carefully built into the current programs. Extremely close attention was paid to the detailed programming of every word. For example, the word is was found in these two sentences: the dog is running, the car is red. These two meanings of is were not only taught separately, it was assumed that more frames were required to teach these two meanings than if these two meanings of is were expressed by two different words.

It was also necessary to program the teaching system itself in considerable detail. The children needed to learn the various techniques employed, such as the use of several choices, the use of a blank in the stimulus, finding the missing words in different parts of a sentence, learning how to start a program, knowing when to stop, etc. These techniques were all programmed systematically. As new concepts were introduced it was necessary to re-teach many of these techniques with the new content. A careful analysis was also made of the illustrations employed. These were revised by simplifying the drawings in order that the concepts would be more obvious. A discussion of program 6 in set 3 will illustrate these points.

Objective

The objective of Program 6 is to introduce the concept sitting within the context Ben is sitting. At the same time a programming technique is further developed. In programs 1 and 2 the children have been introduced to the teaching machine. They learned how to work the machine and reinforcement conditions were established. Programs 3, 4 and 5 introduced the concepts Ben and Janet and also introduced programming techniques. The following techniques have been introduced prior to program 6:

> One or two choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word either appears alone as the correct response or with one distractor.
>
> One or two choice blank: An illustration appears with a blank in the stimulus portion of the frame. A word that corresponds to the illustration either appears alone as the correct response or with one distractor.

It may also be noticed that it is possible for a response to appear with two distractors. However, this is not introduced until Program 8. The technique developed in Program 6 is the use of a sentence in both stimulus and response positions.

Two illustrations are used in presenting the concept Ben is sitting. They are numbered Ben 13 and Ben 26. Both pictures are free of extraneous props such as chairs, desks, and tables, as are the familiar illustrations Ben 1, and Ben 2, which depict the boy, Ben. In the following sample program, the correct response has been underlined. A, B, and C refer to the position of the response on the machine's response panel. The illustration and stimulus appear on another part of the machine.

Figure 10

Frame by Frame Analysis of Program 6

Frame	Illustration	Stimulus	A	B	C
6-01		Introductory Frame			

Figure 10

Continued

Frame	Illustration	Stimulus	A	B	C
6-02	Ben 1	Ben	Ben	Janet	
6-03	Ben 1	Ben		Janet	Ben

Frames 02 and 03 review both the concept Ben and a programming technique. This provides a lead into the following frames where the new concept, Ben is sitting., is presented as an extension of a familiar concept within the framework of a familiar technique.

6-04	Ben 13	Ben is sitting.	Ben is sitting.		
6-05	Ben 13	Ben is sitting.		Ben is sitting.	
6-06	Ben 13	Ben is sitting.			Ben is sitting.

Frames 04, 05, 06 introduce the concept Ben is sitting with a new illustration. The response is varied in position and is not used with distractors.

6-07	Ben 13	Ben is sitting.	Ben is sitting.	Janet	
6-08	Ben 13	Ben is sitting.		Ben is sitting.	Janet

Frames 07 and 08 present the response with a distractor.

6-09	Ben 2	___________	Ben		
6-10	Ben 2	___ ______			Ben
6-11	Ben 13	___________		Ben is sitting.	
6-12	Ben 13	___________	Ben is sitting.		

Frames 09 and 10 review Ben with another familiar illustration and technique. Again, these familiar frames provide a lead into the following frames, 11 and 12, where the response Ben is sitting., is presented with a stimulus picture and a blank.

Figure 10

Continued

Frame	Illustration	Stimulus	A	B	C
6-13	Ben 26	Ben is sitting.			Ben is sitting.
6-14	Ben 26	Ben is sitting.		Ben is sitting.	
6-15	Ben 26	Ben is sitting.	Ben is sitting.		

Frames 13, 14 and 15 depict Ben is sitting. with a new illustration. It is not taken for granted that the children have generalized the concept Ben is sitting. from the illustration of Ben 13. Thus the response is programmed as a new response in varied positions with no distractors.

6-16	Ben 2	Ben		Ben	Janet
6-17	Ben 2	__________	Ben		Janet
6-18	Ben 26	__________		Ben is sitting.	
6-19	Ben 26	__________			Ben is sitting.

Frames 16 returns to Ben. It leads into the following frame where the same choice is given, but the stimulus is blank. Now with the new illustration and a blank stimulus, the appropriate response, Ben is sitting., is to be made.

6-20	Ben 1	Ben		Ben	Janet
6-21	Ben 1	Ben	Janet		Ben
6-22	Ben 26	Ben is sitting.	Janet	Ben is sitting.	
6-23	Ben 26	Ben is sitting.		Ben is sitting.	Janet

The return to Ben in Frames 20 and 21 provides a review of a familiar concept and also a lead into the following frames, 22 and 23, where the new response, Ben is sitting., appears with a distractor. It is also hoped that a break in the frequent exposure to Ben is sitting., provided by Frames 20 and 21, will lessen the tendency to push one response over and over again without actual involvement.

Figure 10

Continued

Frame	Illustration	Stimulus	A	B	C
6-24	Ben 26	________	Ben is sitting.	Janet	
6-25	Ben 26	________	Janet		Ben is sitting.
6-26	Ben 13	________	Ben is sitting.	Janet	
6-27	Ben 13	________		Janet	Ben is sitting.

Frames 24, 25, 26 and 27 provide practice in choosing the response Ben is sitting. when no stimulus is given.

6-28	Ben 1	Ben			Ben
6-29	Ben 13	Ben is sitting.	Ben is sitting.		
6-30	Ben 26	Ben is sitting.		Ben is sitting.	

Frames 28, 29 and 30 review the concepts of the program. As the response for these frames appear with no distractors and a matching stimulus is given, it is hoped that the program will end on a note of encouragement.

The changes that were made in set 3 can also be illustrated by comparison of the contents of the programs of the third set with the contents of the programs of sets 1 and 2. In addition to reviewing what is taught in previous programs, the introduction of words and concepts in the programs is as follows:

Programs 1 and 2 are those used in set 2.

Program 3 introduces two proper nouns with two illustrations and two programming techniques.

Program 4 introduces two new programming techniques.

Program 5 introduces two new illustrations.

Program 6 introduces a verb in one context with two new illustrations.

Program 7 introduces the same verb in a new context with two new illustrations.

Program 8 extends the concept being developed in program 7 with one new technique and more difficult comparisons.

Program 9 extends the concept introduced in program 6 with a new technique and more difficult comparisons.

Program 10 introduces a new concept with two new illustrations.

Program 11 extends the concept introduced in program 10 with two new illustrations and more difficult comparisons.

Program 12 reviews all vocabulary, illustrations, and concepts introduced, within a sequence (story) format.

Program 13 expands the concept introduced in program 6 in a new context with two new illustrations.

Program 14 further develops this concept by more difficult comparisons.

Program 15 reviews all vocabulary, illustrations, and concepts within a sequence (story) format.

Program 16 introduces a new verb in one context with two new illustrations.

Program 17 extends the concept introduced in program 16 by the use of more difficult discriminations.

Program 18 extends the concept introduced in program 16 in a new context with two new illustrations.

Program 19 extends the concept introduced in program 18 by the use of more difficult discriminations.

Program 20 extends the concept introduced in program 18 by the use of more difficult discriminations.

Program 21 extends the concept introduced in program 16 by the use of more difficult discriminations.

Program 22 extends the last two concepts introduced (program 16 and program 18) by comparison with each other.

Program 23 expands the concept introduced in program 16 by presenting it in a new context with two new illustrations.

Program 24 extends the concept introduced in program 23 by the use of more difficult discriminations.

Program 25 extends the concept introduced in program 23 by more difficult discriminations.

Program 26 extends the concept introduced in program 16 by comparing it in the three contexts in which it has been introduced.

Program 27 reviews all vocabulary, illustrations, and concepts within a sequence (story) format.

Program 28 reviews all vocabulary, illustrations and concepts within a sequence format.

Program 29 introduces one noun with two new illustrations.

Program 30 introduces two adjectives with two new illustrations.

Program 31 extends the concept introduced in program 30 by the use of a new technique.

Program 32 introduces an adjectival phrase within two contexts with two new illustrations.

Program 33 extends the concept introduced in program 32 with one new technique.

Program 34 extends the concepts introduced in programs 29 and 32 with two new illustrations.

A more complete description of these programs can be found in Appendix C.

CHAPTER III

EXPERIMENTAL RESULTS

The technical developments described in chapter II were all preparatory to the actual experimentation with deaf children. Three such studies were carried out; they are each described in detail below. These studies were all aimed at the basic issues enumerated as the objectives of the project.

The first study was preliminary; it was primarily one of machine-child interaction to determine the overall feasibility of the approach. Although the study revealed that this approach to the teaching of reading was uniquely suited to deaf children, it was also discovered that both instrumentation and programming needed to be improved.

The second study solved the second major issue, that of instrumentation. A new machine had been designed and built which was well suited to the children and data collection was automated. Still, the programs were too steep. The children's motivation remained at a very high level, but the error rate increased perceptably after the first two weeks of instruction. During this study, many of the major parameters of this particular approach were explored

Preparatory to the third study, the entire reading program was revamped, rewritten and, of course, photographed. The children were taught daily for about six weeks, and motivation appeared to increase during this period. The third issue, the difficulty of the programs, appeared to have been solved, resulting in 34 programs of around 35 frames each for use in beginning reading instruction. The third study was more carefully designed than the first two. It involved two experimental groups and two control groups, and a good deal of basic data were gathered on these children.

Each study will be discussed in detail in terms of design, population studied, results and conclusions. Detailed descriptions of the programs used in each study will be found in appendices A, B and C.

The First Study

The first study was essentially a pilot study. It was conducted at the Minneapolis Hearing Society from July 23 to July 29, 1964. The nine children in the study were brought to the Society daily by their parents.

The subjects were 5 boys and 4 girls who had attended the nursery school which is one of the services of the Society. All of the subjects were profoundly deaf and could be classified as "prelanguage deaf." The age range at the time of the study was from 63 to 79 months. Only one of the subjects was reported to have shown any previous interest in learning words.

The apparatus used was the Honeywell-University of Minnesota Instructional Device (HUMID I), a teaching machine constructed by Honeywell, Inc. Ten programs varying in length from 30 to 53 frames were used. These programs are outlined in appendix A.

A set of standardized directions were developed for this program. (Figure 11) They are given below, with a description of what was done for each frame that was shown to the child. The numbering of the frames is done in such a way that the number before the dash refers to the number of the program, the number after the dash refers to the number of the frame. For example: 1-12 refers to the twelfth frame in program 1.

Figure 11

Standardized Instructions for HUMID Program 1
Experimenter seats himself beside child. Introductory slide shows on screen.

Frame

1-01 The first frame is an introductory frame and is basically the same for all programs. It presents in the stimulus portion of the frame pictures of Janet and Pat, the program number, and other identifying information. Only one response panel is used. It contains a star. The experimenter depresses the panel that contains the star in order to advance the program to the next frame. The presentation of the star is unique to the introductory frame.

1-02 Experimenter points to stimulus, then to the correct response. He then pushes the correct response panel and indicates by gesture (smile, head nodding) that getting a green light is the goal.

1-03 Experimenter points to an empty response panel (A) and indicates by gesture (frown, head shaking) that this is incorrect. He repeats this gesture with the other empty response panel. The experimenter then points to the correct answer (C) and presses that panel indicating again that the green light is the goal.

1-04 Experimenter pushes panel A (Incorrect). He shows through gestures that he is displeased. When red light goes off, he matches carefully and pushes the correct answer, (B). When the green light appears he shows by gestures that he is pleased.

1-05 Experimenter indicates to child that he is to respond. If child fails to do so experimenter may take child's hand and help him to depress the correct response panel.

1-06
1-09 Child does these with increasing independence.

1-10 The experimenter and child should work together to solve the problem. This is the first frame with more than one choice. However, it is basically a demonstration frame. Only the correct answer should be depressed.

1-11 Demonstration frame but child and experimenter should follow the child's indications and depress and panel which the child wants depressed. Experimenter continues to assist the child with the subsequent frames as needed.

1-12
1-16 Child responds to these frames. Independence in responding should be encouraged.

1-17 Demonstration frame. This is the first with three choices. Experimenter follows child's lead but gives needed help.

1-18
1-21 Child does these. Independence is again encouraged, but assistance may be given.

1-22
1-27 Test frames. Child should make response independently.

Learning criterion: Child should make 5 correct responses to the six test frames. If he meets this criterion, proceed to program 2. If he does not reach this criterion, program 1 should be repeated. If he does not reach criterion after repeating program 1, this medium of instruction should be discontinued.

1-28 This is the final frame for program 1. This final frame, as the final frame for all programs, contains pictures of Janet and Ben in the stimulus portion and does not utilize any of the response panels. The experimenter indicates that it signals the completion of the program.

The directions for introducing the machine had been worked out very carefully. However, with this method of introduction, the children appeared quite dependent upon the experimenter and looked for assistance in subsequent programs. They seemed greatly in need of some type of social reinforcement, especially when they made mistakes. It was decided therefore, that when the machine was introduced again, to do it in such a way that the children were encouraged towards independence as soon as possible.

Ten programs were used in the first study and are found in appendix A. The learning criterion level was set at 90% correct response within each program. Each subject was required to repeat each program until criterion level was reached. Two trials with a short break between them were given on each of the five days.

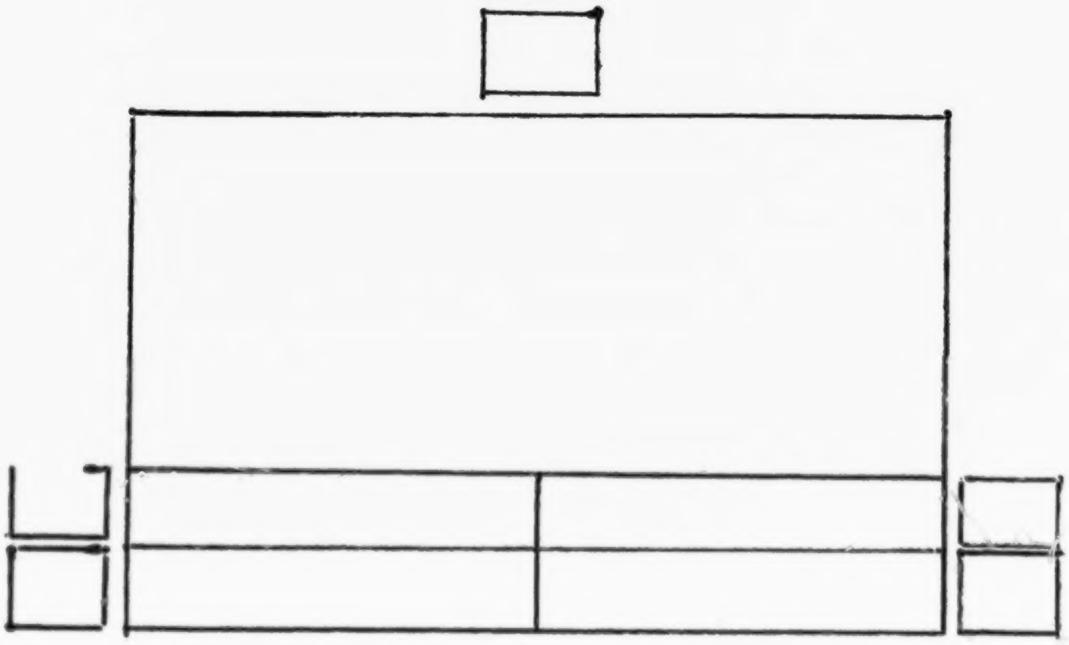
Of the nine Ss, seven reached criterion level on the ninth program on the fifth day. Two of these subjects went on to attempt the tenth program. Of the two subjects who did not reach program 9 one was multiply handicapped (cerebral palsy), the other showed evidence of a response set.

Although the study was informally conducted, many useful observations were made. Most important was the evidence of apparent success achieved throughout the use of these programs and the teaching machine. The children were very much interested in the machine and the presentations, as evidenced by the comments of parents and the actions of the subjects.

A major problem encountered during the study was the general format of the frame. The response choices were placed in four sections in the lower part of the frame. The response buttons were located on the outside of the screen, two on each side (Figure 12). Because of the location of the buttons, the children's finger movements (and probably eye movements) traveled from the middle of the frame toward the button. This procedure was satisfactory for the two responses on the right, but led to a right-to-left pattern for the two choices on the left. This seemed a problem serious enough to demand a change in format of the screen.

Figure 12

Face of HUMID I Teaching Machine



Some technical problems became apparent such as color differential as a function of distance from the center of the screen and letter size differential as a function of the color of adjacent letters and background. Some program revisions seem desirable to provide for greater consistency from frame to frame, better choice of illustration, and more repetition of similar frames.

The first study required two people to operate the equipment, because the record keeping process was very cumbersome. At the same time it was quite unreliable. Also, there was information which needed to be studied, such as response delay, which simply could not be explored with this equipment. Since it was quite obvious that the display itself had to be changed, and all frames re-written and re-photographed, it was decided to try to incorporate an automated print-out device in the new machine.

Although major weaknesses in this system were revealed in this study, the approach itself was considered very successful. In fact, it appeared that an approach had been found which was uniquely suited to deaf children, and that this was the beginning toward an excellent solution to a very complex problem.

The Second Study

The objectives of the second study were to:

1. Determine the usefulness of the redesigned teaching machine, HUMID II.
2. Study several, specific parameters of programmed instruction such as response latency and ways of measuring progress.
3. Determine the adequacy of the new, revised programs.
4. Observe the motivation of deaf children working on a teaching machine for one month.
5. Study a different way of introducing the teaching machine. This study was conducted in the St. Paul Public Schools, St. Paul, Minnesota, from May 4, 1965 to June 4, 1965.

The Sample

Thirteen hearing-impaired children, all of whom were enrolled in Jefferson Public School, were used as subjects in this study. Eleven of these children were in two kindergarten classes for auditorially handicapped children. Six of these eleven attended a morning session and five an afternoon session. Subject number 4 attended the afternoon session for one hour and then joined a normal kindergarten for the remainder of the session. Subject number 2 attended normal kindergarten for both morning and afternoon session. He was attending kindergarten for the second year. All other subjects were in their first year of kindergarten. Data from a thirteenth subject was deleted from the analysis because his poor response to the programs would distort the remainder of the data.

The sample consisted of 7 boys and 5 girls. The IQ range was 80 to 111, the age range from 5 years 10 months to 6 years 10 months. Four of the children were classified by the school as hard of hearing, 5 were severely deaf, and 3 were profoundly deaf. Information on the subjects is summarized in table 3.

Table 3

Description of Subjects

Subject No.	Age	Sex	Leiter IQ	Degree of Hearing Loss*	Days Present
1	5-10	F	98	1	21
2	6-10	M	80	1	14
3	6- 5	M	90	2	20
4	6- 5	M	90	1	18
5	6- 2	F	97**	1	15
6	6- 1	M	100	2	21
7	6- 4	F	10	2	19
8	6- 3	M	100	3	21
9	5-11	F	95	2	17
10	6- 3	M	111	3	20
11	6- 3	M	90	2	17
12	6- 3	F	104	3	21
Mean:	6- 3		97.1		18.7

*Hearing loss categorized as follows:

1. Hard-of-hearing
2. Severe
3. Profoundly deaf

**No Leiter available - Arthur Point Scale was used.

Procedure

The kindergarten classes were introduced to the machine in groups; that is, the class was brought in and given a demonstration of the use of the machine. The experimenter first pressed the panels and indicated by gestures that the green light followed a correct response and the red light followed an incorrect response. After a few demonstration frames, the experimenter allowed the children turns at making choices. After the group demonstration each child was given a chance to complete the first program individually. On the second day, and each day thereafter, each child was given two programs. The first of these programs was usually the last one given the day before, so as to provide review. If the child did sufficiently well on the first program, he was given a new program introducing a new concept. In many cases the subject had to repeat a program several times which suggested that the programs were rather difficult. Training sessions were held over a total of 21 days with an extra day for the post-test. Data collected included whether the response was correct or incorrect, the incorrect choice when one was made, the latency of the responses in seconds, and the total number of responses made to a given program. This information was printed on tape and provided an accurate, neat and usable record of the subject's performance.

Equipment and Programs

The equipment used for the study was the teaching machine, HUMID II.

Programs used were developed especially for this machine by the project staff. Each program consisted of approximately 30 frames (slides), each of which had a stimulus and one, two, or three response alternatives. Fourteen programs were used for teaching and a test program was given on the final day. These programs are described in detail in appendix B.

Results

The number of programs responded to varied from 11 to 14, except for one subject who did only nine programs. The number of programs for each subject depended on days attended and his performance. The program which required the most repetitions was Program 8, in which runs was reviewed and sits was introduced.

Latency of response measures were used in the analysis. The mean latencies for the children ranged from 3.43 seconds to 7.31 seconds, with individual standard deviations ranging from .68 to 4.27. The subject with the shortest mean latency went through the least programs and was one of two subjects making the highest number of errors on the posttest. Detailed information on response latencies is given in table 4.

Table 4

Response Latencies During Training

Subject No.	Mean Latency over Training Programs	Variance of Mean Latency	Standard Deviation	No. of Programs
1	4.78	1.79	1.34	11
2	5.18	1.62	1.27	11
3	6.53	6.17	2.48	11
4	6.15	18.22	4.27	12
5	7.31	6.66	2.58	12
6	4.65	2.61	1.62	12
7	4.69	4.67	2.16	12
8	4.45	2.01	1.42	12
9	3.96	.46	.68	14
10	3.58	1.04	1.02	12
11	3.43	.69	.83	9
12	4.83	1.68	1.30	14

When Leiter IQ scores were correlated with mean latencies and variances, non-significant negative correlations (-.34 and -.22, respectively) were found. In order to study the relationship between response latency and frame difficulty, a comparison was made of the response latencies to a moderately easy program and one which was moderately difficult. Programs 5 and 9 were chosen for this analysis. In these programs the following three kinds of frames were analyzed separately: One choice matching: an illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel. Two choice blank: an illustration appears with a blank in the stimulus portion of the frame. A word that corresponds to the illustration appears on a response panel. A different word appears as a distractor on another response panel.

Three choice blank: an illustration appears with a blank in the stimulus portion of the frame. The word that corresponds to the illustration appears on a response panel. Two different words appear as distractors on other response panels. Table 5 shows the mean latencies for these three kinds of frames on the two programs when a correct response was made on a first choice and when an error was made. It was hypothesized that the one choice matching would be easiest, the two-choice blank next easiest and the three-choice blank frame the most difficult and that these levels of difficulty would be evidenced by increasing latencies. Indications that this was true are given in the table.

The relationship between response latencies and the correctness of the response was also studied at this time. It was revealed that the chilren tended to respond faster when they made mistakes, a finding which is contrary to what other researchers have found. It is, however, consistent with the other results of this study reported in table 5.

Table 5

Mean Response Latencies for Programs 5 and 9

Number of Alternatives	Type of Item	Correct Response on First Choice		Errors		Total	
		P. 5	P. 9	P. 5	P. 9	P. 5	P. 9
1	Matching	3.83	4.98	4.00*	2.07	3.76	4.60
2	Blank	4.41	6.88	3.40	6.86	3.85	5.80
3	Blank	5.24	8.32	3.75	6.44	4.49	6.15

P= Program

*This average lacks reliability, since it includes only 4 errors.

It was concluded from these data that as the frames became more difficult, response latency increased. Also, as additional distractors were introduced, response latency increased. When the children took more time, they tended to respond with a higher degree of accuracy. The use of three choices in a teaching machine for children of this age would appear to be very satisfactory.

One of the most common findings of studies of school learning among children of the ages studied here is rather pronounced sex differences. Because of the relatively small number of children used in this experiment it was difficult to study sex differences. They were explored, however, but sex differences in learning among the subjects studied here could not be discerned.

It might also be noteworthy that no child developed any kind of a response set, nor was there any child who could not handle this learning system. The one child who had great difficulty learning was multiply handicapped and appeared to be somewhat retarded. He could handle the system, but had difficulty with the concept taught.

Posttest Data

Thirty-four items were used in the posttest program. The number of correct initial response ranged from 9 to 28. Mean response latencies on the posttest ranged from 2.03 to 12.24. Posttest data are shown in table 6,

When posttest scores and posttest latencies were correlated a product moment correlation coefficient of .56 was found. This was significant at the .10 level. The Leiter IQ scores showed a correlation of .46 with the posttest scores. This was a non-significant correlation.

In other words, the slower responding child tended to work with much greater accuracy than did the faster child. Also, the brighter child tended to do better than the less bright child. In this study, response latency correlated positively with response accuracy. This is contrary to what some programmed learning researchers have reported, who find the faster children to also be more accurate, as well as brighter.

It seems quite evident that the test programs were very difficult. There are many possible reasons for this. Items were included from all programs, 1-14. This means that many of the children were required to make responses to unfamiliar stimuli from programs

Table 6

Performance on the Posttest

Subject No.	No. of Correct First Responses	Total No. of Responses	Mean Latency of Responses
1	9	74	3.13
2	16	57	3.21
3	15	63	7.63
4	21	51	10.41
5	20	51	12.24
6	17	56	6.35
7	14	62	4.24
8	12	68	4.72
9	28	41	6.40
10	11	60	5.20
11	12	74	2.03
12	16	60	3.48
Mean:	15.9	59.75	5.75

to which they had not been exposed. The test items were randomized. Had they been in the order of increasing difficulty the children may have been encouraged by success in the early frames. All items in the test program had three response alternatives. In other programs there were always varying number of alternatives.

The Third Study

The objectives of the third study were to:

1. Conduct a carefully controlled study with the revised programs.

2. Determine the contributions of the HUMID system to the developmental reading program of deaf first graders.

3. Determine the contributions of the HUMID system to the remedial reading program of deaf 9 and 10 year-olds.

4. Study several of the unique parameters of this mode of reading instruction.

The third study was conducted in the Minneapolis Public Schools, Minneapolis, Minnesota, from April 14, 1966 to June 1, 1966.

Forty children in Agassiz Public School, were used as subjects in this study. The children were divided into two groups. Group I consisted of twenty children who were enrolled in four first year, first grade classrooms (I-I) for auditorially handicapped children. Group II consisted of twenty older children who were enrolled in six classrooms for auditorially handicapped children with learning problems. Of the twenty children in each group, ten were assigned to an experimental group and ten were assigned to a control group. Subjects in the experimental groups were released from the classroom approximately fifteen minutes during the school day to complete a program of experimental instruction. Subjects in the control groups received classroom instruction during that time. The groups were chosen randomly, but when divided into experimental and control groups they were equated for IQ, age, sex, hearing and language performance. The two approximately equal groups at each age level were randomly assigned to treatment.

The sample in Group E-1 consisted of four boys and six girls. The IQ range on the Nebraska Test of Learning Aptitude was 94 to 134, the age range was from 7 years 0 months to 8 years 6 months. Three of the subjects were classified by the educational consultant at the school as hard-of-hearing, three were classified as severely deaf, and four as profoundly deaf. Four of the subjects were classified by the educational consultant at the school as having superior language, one was classified as having average language, and five were classified as having poor language, the classification being a relative one. Information on the subjects in Group E-1 is summarized in table 7.

Table 7

Description of Group I-Experimental (E-1)

Subject No.	Age	Sex	IQ	Degree of Hearing Loss	Degree of Language Ability**
1	8-5	F	133	2	1
2	7-7	F	128	3	3
3	7-0	M	121	2	3
4	8-6	M	102	3	3
5	7-10	F	94	1	1
6	7-3	M	102	1	3
7	7-2	F	117	1	1
8	7-0	F	134	3	1
9	8-3	M	134	3	3
10	7-0	F	102	2	2
Mean:	7-6		117		

*Hearing loss categorized as follows:
1. Hard-of-hearing
2. Severely deaf
3. Profoundly deaf

*Language categorized as follows:
1. Superior
2. Average
3. Poor

The sample in C-1 consisted of six boys and four girls. The IQ range was from 89 to 147, the age range was from 7 years 2 months to 8 years 5 months. Three of the subjects were classified as hard-of-hearing, four were classified as severely deaf, and three as profoundly deaf. Four of the children were classified by the school as having superior language, four were classified as having average language and two were classified as having poor language. Information on the subjects in C-1 is summarized in table 8.

Table 8

Description of Subjects in Group I: Control C-1

Subject No.	Age	Sex	IQ	Degree of Hearing Loss	Degree of Language Ability
1	7-8	M	120	1	2
2 23 2	8-5	M	110	1	2
3	8-4	F	102	3	3
4	7-10	M	91	2	2
5	8-5	M	118	3	1
6	8-3	M	147	2	1
7	7-2	F	89	2	2
8	7-3	F	102	2	1
9	8-5	M	140	1	1
10	7-7	F	113	3	3
Mean:	7-11		113		

The sample in E-2 consisted of seven boys and three girls. The IQ range was from 79 to 128, the age range was from 9 years 4 months to 11 years 1 month. Seven of the children were classified as hard-of hearing, three were classified as being severely deaf and none were classified as being profoundly deaf. None of the children were classified as having superior language, two were classified as having average language and eight as having poor language. Information on the subjects in the E-2 group is summarized in table 9.

Table 9

Description of Group II - Experimental
E-2

Subject No.	Age	Sex	IQ	Degree of Hearing Loss	Degree of Language Ability
1	9-6	M	116	2	3
2	10-6	M	128	2	3
3	11-1	M	79	1	3
4	10-11	M	102	2	3
5	10-1	F	88	1	3
6	11-0	F	100	1	3
7	10-3	M	79	1	2
8	10-4	M	108	1	2
9	10-3	M	96	1	2
10	9-4	F	81	1	3
Mean	10-4		98		

The sample in C-2 consisted of five boys and five girls. The IQ range was 70 to 127. The age range was from 7 years 7 months to 11 years 10 months. Five of the children were classified as hard-of-hearing, four were classified as severely deaf and one as profoundly deaf. None of the group were classified as having superior language, four were classified as having average language and six as having poor language. Table 10 summarizes the information on these subjects.

Table 10

Description of Group II - Control
C-2

Subject No.	Age	Sex	IQ	Degree of Hearing Loss	Degree of Language Ability
1	9-4	F	80	1	3
2	10-10	F	70	2	3
3	11-4	F	127	2	2
4	7-7	M	95	3	3
5	10-5	M	89	1	2
6	10-11	F	104	1	3
7	11-5	F	102	2	3
8	11-10	M	100	2	3
9	9-2	M	110	1	2
10	10-2	M	91	1	2
Mean	10-4		97		

Table 11 summarizes the data on all four groups. The slight differences between experimental and control groups were found to be nonsignificant.

Table 11

Summary of descriptive data of all four groups

Group	N	Mean Age	Sex M	Sex F	Mean IQ	Hearing H. H.	Hearing Sev.	Hearing Prof.	Language Sup.	Language Av.	Language P.
E-1	10	7-6	4	6	117	3	3	4	4	1	5
C-1	10	7-11	6	4	113	3	4	3	4	4	2
E-2	10	10-4	7	3	98	7	3	0	0	3	7
C-2	10	10-4	5	5	97	5	4	1	0	4	6

Procedure

Subjects in the experimental groups were introduced to the machine individually. Two introductory programs (Programs 1 and 2) were developed to teach the use of the machine. These programs consisted of matching a stimulus picture to a correct response which might appear singly or with one or two distractors.

With the subject seated at the machine, the experimenter pointed first to the stimulus picture and then to the correct response. Indicating approval by gesture (smile, head-nodding), he then pushed the correct response panel. As the green light illuminated the response panels, the experimenter again indicated approval. Next, the experimenter pointed to the stimulus picture and to an incorrect response. Indicating disapproval by gesture (frown, head-shaking) he then pushed the incorrect response panel. The resulting red light on the response panels elicited disapproval from the experimenter.

The subject was then encouraged to respond on his own. If assistance was needed, the experimenter helped the subject to match the stimulus picture with the correct response, and to re-establish the green light as a signal for the correct response. The experimenter moved away from the machine as soon as the subject appeared confident allowing the subject to complete the program independently.

Upon successful completion of Program 1, the subject completed Program 2 independently. No child had any difficulty with this procedure.

During the remaining days of the study, each subject proceeded through two or three programs; generally two were completed. The subject first completed a program for review which was the final program completed on the previous day. If the subject responded with 90% or better accuracy on this program, he completed a new program. If the subject responded with less than 90% accuracy on the review program he completed that program a second time rather than proceeding on to a new program. The following day the subject would again repeat once the same review program and regardless of whether he reached criterion level, he proceeded on to a new program. Each program was therefore done a minimum of two times or a maximum of four times.

Three programs per day were assigned when a subject had been absent for several days. If the subject had been achieving above criterion level, he was assigned three programs per day in order that he might complete the series. The first program again was the last program the subject had completed. The second and third programs would be new programs if the previous program were completed successfully. The following day the same procedure was repeated. Data collected included a record of both the correct or incorrect responses, incorrect response when one was made, the latency of each response in seconds, and the total number of responses made to a given program. This information was provided by the HUMID recording device.

The programs were administered over a total of 35 days with an additional day for posttesting. Two posttests were administered to both the experimental and the control groups. Both were paper and pencil tests and were administered to the children in small groups. One posttest, the HUMID test, tested the concepts taught in the 34 programs. It consissed of forty multiple-choice items. The stimuli consisted of copies of the illustrations used in the programs. The three choices consisted of words, phrases or sentences taught in the programs. Sample items from this test are given in appendix E.

In two items, the words red and green, which had not been included in the experimental instruction, appeared as adjectives in phrases of which the structure was known. The phrases a red box and a green box were used as distractors. The third item contained the phrase a yellow cat as a distractor. Although the words and the structure had been taught, the combination was new. The second test was the Stanford Achievement Test, Primary 1, Word Reading and Paragraph Meaning subtests (Kelley, et. al. 1964).

Equipment

The equipment used for the study was the teaching machine, HUMID II, and its print-out recorder.

The programs used were those specifically developed for this study. Each program consisted of 30 some frames (slides), each of which had a stimulus and one, two, or three response alternatives. Thirty-four programs were used during training.

Results: Program Data

The experimental learning series consisted of 34 programs. Nineteen of the twenty subjects completed 34 programs. One subject was unable to complete the programs due to absenteeism. He completed 32 programs.

As a general rule, the first program was to be completed once by each subject and the remaining 33 programs were to be completed twice. However, circumstances sometimes necessitated a program's being done more than 2 times, occasionally once. Every child did the first program once. The total number of programs completed by a subject varied from 56 to 69 with a mean of 64 being completed for E-1 and E-2 and the two groups combined. Table 12 shows these data.

Table 12

Total Number of Programs Completed by Subjects

Subject:	1	2	3	4	5	6	7	8	9	10	$\bar{X}$
E-1	64	64	65	66	63	62	69	65	56	66	64
E-2	65	64	67	65	56	64	64	67	65	63	64
Total											64

The total number of errors per subject was calculated for Programs 2 through 34 for each program the subject completed. The errors for Program 1 were not included because this was a training program and the subject and experimenter worked together on it. The total number of errors varied from 4 to 142. The average number of errors was 42.05 for all subjects, 54.6 for E-1 and 29.5 for E-2. See Table 13 for these data.

Table 13

Total Number Errors Made by Subjects: Program 2-33

Subject:	1	2	3	4	5	6	7	8	9	10	$\bar{X}$
E-1	26	39	85	75	16	29	142	16	56	62	54.6
E-2	26	4	27	15	12	22	64	28	67	30	29.5
Total											42.1

Because the number of programs completed by each subject varied, the average number of errors per child per program was calculated. The averaged number of errors ranged from .06 to 2.09. The average number of errors over all subjects was .66 with an average of .86 for E-1 and an average of .47 for E-2.

Testing with a t-test, there were no significant differences between group means at the .05 level. The standard deviation for E-1 was .57, for E-2 .33, and the pooled standard deviation for both groups combined .47. Testing with an F-test, no significant differences were found between group variances.

Table 14

Average Number of Errors Made Per Program

Subject:	1	2	3	4	5	6	7	8	9	10	$\bar{X}$	S.D.
E-1	.41	.62	1.33	1.15	.26	.48	2.09	.25	1.02	.95	.86	.57
E-2	.41	.06	.41	.23	.22	.35	1.02	.42	1.05	.48	.47	.33
Total											.67	.47

The total number of errors made on the first trial of a given program for Program 2 through 34 were calculated. The total number of errors for Group 1 was 26.1, for Group II 15.5 and for all subjects was 20.8. Table 15 contains these data.

Table 15

Total Errors on Trial 1 of Each Program

Subject:	1	2	3	4	5	6	7	8	9	10	$\bar{X}$
E-1	17	17	42	25	9	13	64	11	35	28	26.1
E-2	16	2	1	13	9	9	29	13	36	17	15.5
Total											20.8

Because one child completed only 31 out of the 33 programs, the groups were compared on mean number of errors per program on the first trial of each program. The minimum average number of errors on the first trial of all programs attempted was .06 and the maximum was 1.94. The mean number of errors for E-1 was .80 for E-2 .47 and for the entire group it was .64.

There was no significant difference at the .05 level between group means when tested by a t-test. The standard deviation for E-1 was .52, for E-2 .43, and the pooled standard deviation was .47. Tested by an F-test, there were no significant differences between variances at the .05 level. See Table 16 for these data.

The response latencies of these children were also analyzed. Since each one gave around 2,500 responses, it was considered unnecessary to analyze the data for the total group. So, a subsample of 5 subjects were randomly chosen from each group. The mean response latency per frame for the 10 subjects in these subsamples were calculated. The mean latencies per subject ranged from 2.4 seconds to 4.2 seconds per frame. The mean latency for subjects on E-1 subsample was 3.11 seconds, in the E-2 subsample it was 3.29 seconds, and in the total sample it was 3.20 seconds. The standard deviation in E-1 was .74 and in E-2 .42. The pooled standard deviation was .61. There was no significant difference between group means when tested by a t-test. There was no significant differences between standard deviations when tested by an F-test.

Table 16

Average Number of Errors Per Program on Trial 1 of Each Program

Subject:	1	2	3	4	5	6	7	8	9	10	$\bar{X}$	S. D.
E-1	.52	.52	1.27	.76	.27	.39	1.94	.33	1.13	.85	.80	.52
E-2	.49	.06	.33	.39	.27	.27	.88	.39	1.09	.52	.47	.30
Total												.43

The above data are all summarized in table 17.

Table 17

Group Data from the Programs of the Third Study

	Group I	Group II	Total Group
Number Programs completed	64	64	64
Total Errors	54.6	29.5	42.1
Errors per program	.86	.47	.66
SD of errors per program	.57	.33	.47
Total errors on trial 1 program	26.1	15.5	20.8
Errors per program on trial 1	.80	.47	.64
Programs 2-33			
SD of errors per program on trial 1 - Programs 2-33	.52	.30	.43

The standard deviation of the mean latencies of the program for each subject in the subsample was also calculated. The smallest standard deviation for the mean latency was .04 and the largest standard deviation for the mean latency was .87. The mean standard deviation for E-1 was .44. For E-2 it was .55 and for the two groups it was .50. The standard deviation of E-1 is .3, of E-2 is .1 and overall is .2. There were no significant differences between group means or standard deviations at the .05 level.

Table 18

Subsample Results on Latency

Group No.	Subject No.	X̄ Latency	S. D.
I	1	2.41	.32
I	3	3.30	.63
I	4	4.29	.87
I	6	2.60	.38
I	8	2.94	.04
I	X̄	3.11	.44
I	S. D.	.74	.30
II	1	3.35	.55
II	3	3.86	.64
II	4	2.66	.27
II	8	3.28	.52
II	9	3.30	.56
II	X̄	3.29	.55
II	S. D.	.42	.10
I, II	X̄	3.20	.50
I, II	S. D.	.61	.20

The data pertaining to latency are summarized in table 18. These could be compared to the data in table 4, dealing with the second study. It will be noticed that the children in the third study responded considerably faster, indicating that the third set of programs was much easier than the second.

The standard deviation increased with difficulty; within programs it appeared extremely stable within individuals, but varied somewhat from one person to another. Since response latency appears to be primarily idisyncratic in nature, its measurement did not contribute much to the assessment of learning. It might, however, relate to other aspects of child development, possibly in the spheres of personality or social development.

Results: Posttest Data

The HUMID posttest was given to all four groups. It consisted of 40 items, measuring the concepts taught in the programs of set 3. The raw scores for the experimental subjects ranged from 20 to 40. The average number of correct response per group ranged from 35.8 to 39.9. Group E-1 had the highest mean followed by E-2, C-2 and C-1.HUMID posttest data are shown in table 19.

Table 19

Performance on Humid Posttest

Group											
E-1	40	40	40	40	40	40	40	40	39	40	39.9
C-1	34	32	30	34	40	40	38	40	38	32	35.8
E-2	39	40	39	40	40	39	38	38	40	39	39.2
C-2	37	20	40	40	40	40	40	40	39	38	37.4

The statistical analysis of the significance of the difference between the means of E-1 and C-1 could not be done in the usual manner because of the peculiarity of the distribution of raw scores of the children in E-1 (See table 19). The groups were dicotomized, dividing them into those who had a perfect score of 40, and those who did not. A Fisher's exact test of independence yielded on exact probability of evidence for association of .009. Thus, E-1 was significantly superior at the .01 level.

The same statistical analysis was used to study the differences between E-2 and C-2. Although the experimental children did, on the average, better than the controls, the exact probability of evidence for association was only .23, which was not considered statistically significant.

The children in all four groups were also given the Stanford Achievement Test, Primary I, Word Reading and Paragraph Meaning subtests. These tests were administered by the instructional supervisor of the classes for the hearing impaired. In the case of all posttests it was observed that these youngsters tended to make a response to every item, even if they were just guessing. Because of the fact that the HUMID test was too easy to get much variation in scores, the guessing did not affect the scores on that test to any appreciable extent. The Stanford Achievement Test, however, was sufficiently difficult to affect the total score. There was no correction for guessing, and these children did much more guessing than the normal children upon whom the test was standardized, thus yielding somewhat inflated scores for all the deaf children.

The Word Reading test had altogether 35 items. The raw scores of the subjects ranged from 9 to 33. The grade scores of the subjects ranged from 1.2 to 2.9. The mean number of correct responses per group ranged from 18.1 to 21.1. Mean grade scores ranged from 1.78 to 1.86. E-2 and C-2 had the highest raw score means, which were equal. There was no significant difference between E-1 and C-1.

Neither was there any significant difference between the standard deviations of the two pairs of data. The data from the Word Reading test are given in table 20.

Table 20

Performance on the Stanford Achievement Test: Word Reading

E-1												
RS*	29	13	16	25	20	17	22	28	16	15	20.1	5.67
GS**	2.4	1.4	1.6	2.0	1.7	1.6	1.8	2.3	1.6	1.5	1.79	.33
C-1												
RS	15	12	14	15	33	19	10	26	22	15	18.1	7.06
GS	1.5	1.4	1.5	1.5	2.9	2.3	1.3	2.1	1.8	1.5	1.78	.51
E-2												
RS	18	24	17	24	27	25	18	20	29	9	21.1	5.90
GS	1.7	1.9	1.6	1.9	2.2	2.0	1.7	1.7	2.4	1.2	1.83	.33
C-2												
RS	18	24	17	24	27	25	18	20	29	9	21.1	5.90
GS	1.7	1.9	1.6	1.9	2.2	2.0	1.7	1.7	2.4	1.2	1.83	.33

*Raw Score
**Grade Score

The Paragraph Meaning test of the Stanford Achievement Test consisted of 38 items. The raw scores for all four groups ranged from 6 to 32. The grade scores of all subjects ranged from 1.5 to 2.5. The mean raw scores for the four groups ranged from 14.6 to 18.2. The mean grade scores ranged from 1.67 to 1.77. The E-1 group achieved the highest mean raw score and grade score, followed by C-2, E-2 and C-1. Data on the Paragraph Meaning subtest of the Stanford Achievement Test are shown in table 21.

Table 21

Performance on Stanford Achievement Test: Paragraph Meaning

	Subject Number											
Group	1	2	3	4	5	6	7	8	9	10	$\bar{x}$	S.D.
E-1												
RS	31	10	18	24	17	8	26	28	13	17	18.2	8.56
GS	2.4	1.5	1.4	1.9	1.7	1.4	2.0	2.1	1.6	1.7	1.77	.33
C-1												
RS	9	8	6	13	29	32	11	14	15	9	14.6	8.86
GS	1.5	1.4	1.3	1.6	2.2	2.5	1.5	1.6	1.6	1.5	1.67	.37
E-2												
RS	13	18	14	20	20	29	27	20	26	9	17.6	6.98
GS	1.6	1.7	1.6	1.7	1.7	2.2	1.4	1.7	2.0	1.5	1.71	.22
C-2												
RS	7	8	31	14	19	17	21	27	27	10	18.1	8.45
GS	1.4	1.4	2.4	1.6	1.7	1.7	1.8	2.0	2.0	1.5	1.75	.32

The data from the Paragraph Meaning test were analyzed by the same procedure as for the Word Reading test. None of the pairs of means and standard deviations differed at a statistically significant level, although E-1 did better than C-1 at a level which approached statistical significance.

The summary statistics from all posttest data are given in table 22.

Table 22

Summary of Postest Data

Group	HUMID	STANFORD ACHIEVEMENT TEST							
	Post-test Mean	Word Reading				Paragraph Meaning			
		Raw Score		Grade Score		Raw Score		Grade Score	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
E-1	39.9	20.1	5.67	1.79	.33	18.2	8.56	1.77	.33
C-1	35.8	18.1	7.06	1.78	.51	14.6	8.86	1.67	.37
E-2	39.2	21.1	5.90	1.83	.33	17.6	6.98	1.71	.22
C-2	37.4	21.1	6.84	1.86	.40	18.1	8.45	1.75	.32

Student Research

Project HUMID is novel in a great many respects. There is innovation in technology, instructional methodology, and research methodology. For this reason it seems to lend itself very nicely to student research and to a multitude of smaller, well-defined studies. The teaching machine modality itself is one which has not been exhaustively studied, and the possibilities of doing translational research, translating what is generally hypothesized about human learning into an actual, practical learning situation is inherently intriguing to the educational psychologist.

As of the writing of this report five student studies have been completed within this project. The first one, a MA study by Joanne Protheroe (1965), studied the effect of reinforcement for incorrect responses. She compared the relative efficacy of using a red light vs. no light as a reinforcer for an incorrect response. In a Ph. D. study by Donovan McClard (1966) a social reinforcement parameter was explored in conjunction with teaching machines, the social reinforcer being the child's mother. Alvin Price (1966) also studied social reinforcement in his doctoral dissertation using peers as social reinforcers. Beatrice Moosally (1966) studied the effects of delay of reinforcement upon learning in a teaching machine in her dissertation. Finally, in a study which yielded perhaps the most dramatic results, Howard Bird (1966) explored the effects of the use of 3-dimensional print in a teaching machine. A more detailed description of these studies are given below.

Joanne Protheroe: A Study of the Effect of Reinforcement for Incorrect Responses on Learning of Kindergarten Children.

Studies have uniformly found that preschool children learn more quickly in situations where they receive a definite signal for a correct response and a different definite signal for an incorrect response than in situations where they receive a definite signal for a correct response and no signal for an incorrect response. These differences were significant where signals consisted of primary reinforcers (reinforcer being defined as the aftereffect of either a correct or incorrect response) but were not significant when signals consisted of secondary reinforcers.

In the present study the following null hypothesis was tested: In the performance of a learning task, when knowledge of results is the major motivating event, there will be no significant differences in learning between two groups of kindergarten children, one of which receives a green light following a correct response and no light following an incorrect response.

A study was conducted using sixteen kindergarten children as subjects. All subjects completed six programs which were designed to teach kindergarten children to read eleven nouns. The programs were presented in the teaching machine HUMID I. The sixteen children were divided into two matched groups. Group RL (red light) was rewarded for a correct response by a green light and was "punished" for an incorrect response by a red light. Group NL (no light) was rewarded for a correct response by a green light, while an incorrect response was indicated by the absence of a green light.

A pretest consisting of presentation of the eleven words to be taught in the programs was administered to every child enrolled in a kindergarten class in a suburban public school. Of 54 children pretested, 51 were unable to respond correctly to any of the words. From these 51 children, sixteen children were chosen as subjects. These sixteen children were divided randomly into two groups. Subjects in Group RL had a mean age of 6-1 and a mean score on the Metropolitan Readiness Test of 74.4. Group NL had a mean age of 6-1 and a mean score on the Metropolitan Readiness Test of 76.5. There were no significant differences between groups at the .05 level of significance on either age or readiness measures.

Six programs, each containing 25 to 34 frames were used. Program 1 taught the use of the machine. The standardized directions given earlier were used with this program. All children received the same instructions with the exception that children in Group RL were told that when they pushed the wrong button it would turn red, and children in Group NL were told that when they pushed the wrong button it would not turn green. The programs which taught the eleven nouns were Programs 2 through 5. Program 2 introduced the words dog and coat; Program 3, ball, flag, and drum; Program 4, car, cat, and dress; and Program 5, bat, box, and string. In these programs, a picture and a noun describing it were presented in the stimulus portion of the frame. At first, only the correct answer was presented in the response portion and in later frames incorrect answers were added. Each noun was presented several times in this manner and various pictures were used to represent each noun. Eventually a picture with a blank instead of a noun was presented and the child was required to respond to the correct noun. Programs 3, 4, and 5 also included review frames. Program 6 was a posttest. Each noun presented in Programs 2 through 5 was presented twice in this program. A picture and a blank were found in the stimulus portion of each frame and one correct response and three incorrect responses were found in the response section.

Programs 2 through 5 were presented on four consecutive school days beginning on the third day after the completion of Program 1. Program 6 was administered on the third day after the completion of Program 5.

Results

Five measures of learning were used:

1) The total number of response on Programs 2 through 5. These programs total 122 frames and therefore have a minimum of 122 responses. Each response over a total of 122 indicates an incorrect response. Group RL showed a mean of 166.6 responses and Group NL showed a mean of 152 responses. The difference was not significant at the .05 level.

2) The time to complete Programs 2 through 5. Group RL showed a mean time of 25.1 minutes and Group NL showed a mean time of 23.4 minutes. The difference was not significant at the .05 level.

3) The number of times the subject responded correctly on the first attempt to respond to any frame on the posttest. The posttest consisted of 22 frames. Therefore, the highest possible score on this measure would be 22, i.e. every frame would be responded to correctly on the first attempt. Group RL showed a mean score of 9.7 and Group NL showed a mean score of 11.7. The difference was not significant at the .05 level.

4) The total number of responses on the posttest. Because there were 22 frames the minimum number of responses was 22. Group RL showed a mean of 45.6 responses whereas Group NL showed a mean of 38.4 responses. The difference was not significant at the .05 level.

5) The time taken to complete the posttest. Group RL showed a mean time of 5.9 minutes and Group NL showed a mean time of 5.4 minutes. The difference was not significant at the .05 level.

Discussion and Conclusions

The generally low scores were due to insufficient stress on making the initial response to a frame correct, difficult learning programs, a difficult posttest, a three day interval between completion of the learning programs and the posttest. Generalization to other programmed learning situations from these results should be done cautiously because the difficulty of these programs did not make this a true programmed learning situation.

Conclusions:

Three general conclusions can be drawn from this study:

1) Children of kindergarten age can learn responses to stimuli presented in this manner with either of the types of reinforcement for an incorrect response used in this study.

2) The group which did not receive the red light, Group NL, consistently received the better score on each of the five measures of learning analyzed. None of these results were statistically significant, however.

3) The results of the study showed that the null hypothesis could not be rejected.

Q. Donavon McClard: The Effects of Social Reinforcement on Deaf Children's Performance in Auto-Instructional Learning

This study was an investigation of the incentive value of female parent and strange female adult approval on the acquisition of a sight vocabulary by young deaf boys. The sight vocabulary was taught by a visual, non-aural method on an automated programmed instruction device.

Twelve first grade boys attending the Minneapolis (Minnesota) Public School classes for the hearing handicapped were selected for the study. The selection criteria for the subjects were: educational classification as deaf, chronological age between 6-0 and 7-0, freedom from handicaps other than deafness, and inexperience in formal reading instruction.

The learning task was the acquisition of a sight vocabulary of 24 nouns presented in six linear programs of 50 frames each. During learning the subjects were required to make progressively finer discriminations of the noun word from distractor words. The programs were presented on the HUMID II teaching machine.

Social reinforcement was defined as color photograph of the adults with facial expressions of approval. A light stimulus reinforcement, projected as a variable color light field, was used as control for novely effect. Reinforcements were projected on the screen of a mock television receiver adjacent to HUMID. The subjects were administered reinforcement on the first and each succeeding fifth correct response to a program. The reinforcement was changed to a different picture of the same adult during social reinforcement, and to a different color light during the light stimulus condition.

A replicated cross-over Latin Square design was used with each subject learning under each of the three reinforcement conditions. Five criterion measures were obtained on each subject: total number of responses to programs, errors on program test frames, errors on a programmed posttest, words correct on a delayed recall test, and gain in words identified between a pretest and posttest.

It was hypothesized that the type of reinforcement administered during training would differentially affect learning; that social reinforcement would be more effective than the light, and that the mother would be more effective than the strange female adult. Effectiveness was defined as fewer errors during learning and better retention in recall.

The results indicated that the method was effective with deaf boys. The subjects made an average gain of 7.5 words; doubling their initial score in ninety minutes of instruction. Social reinforcement, as defined in this study, was not significantly better than the light reinforcement. The parent picture stimulus was significantly better ($p < .05$) than the strange adult stimulus on two of the measures of learning. A persistent though statistically non-significant superiority of the parent stimulus condition was found on all criterion measures.

A rank order correlation between succeeding periods of training was computed to compare stability of measures. The agreement between subject rank on two periods was .58. The coefficient of concordance between subjects' scores on the five measures was .82.

Tentative hypotheses about learning in deaf children were presented: that they are as developmentally advanced as nonhandicapped peers in response to social approval, that the substitution of a symbolic form of social reinforcement may not be as effective as the presence of an adult, that knowledge of performance may be a sufficient condition for the reinforcement of learning, and that programmed instruction is an effective means of teaching a sight vocabulary.

Alvin Price: The Effects of Subject Response Mode and Peer Social Reinforcement on Children's Learning in Programmed Instruction.

The purpose of the present study was to explore the effect of social reinforcement and response mode parameters on the acquisition of a sight vocabulary in nonreading, normal kindergarten children. The sight vocabulary was taught on an auto-instructional device.

Sixty kindergarten children attending a suburban St. Paul (Minnesota) public school were selected for the study. The selection criteria for the Ss were: inability to recognize the training words on a screening test and satisfactory kindergarten performance as measured by pro motion into first grade.

The learning task was the acquisition of a sight vocabulary of twenty-four nouns presented in a series of training programs. During the learning the Ss were required to make progressively finer discriminations of the noun word from distractors. The programs were presented on the HUMID teaching machine.

Social reinforcement was defined as the presence of a non-interacting peer during the training trials. The peer reinforcing agents sat behind the Ss and observed the Ss work the training programs. A comparison was made of the posttest scores on the criterion test between Ss who had a peer present and Ss who did not have a peer present during the training sessions. A further comparison was made between the posttest scores on the criterion test between the Ss who responded overtly to the programs and the Ss who responded covertly to the programs. Covert responders, in this study, were defined as those Ss who observed another child respond overtly to the training task.

Two performance measures were obtained on the Ss in this study: the total number of response per training program for those Ss who responded overtly to the training programs, and the number of correct responses on a criterion test administered before and after the training sessions.

It was hypothesized that the presence of a non-interacting peer during the training sessions would lead to more effective learning for Ss than the absence of such a peer. It was also hypothesized that Ss who responded overtly to the training programs would have higher posttest scores than Ss who responded covertly to the training programs, but that these latter Ss would also score higher on the posttest than Ss in a control group who were not exposed to the training programs.

The results indicated that the method used was effective with kindergarten children. *S*s who worked in the presence of a non-interacting peer did not have significantly better posttest scores on the criterion test than *S*s who worked by themselves. There is tentative evidence that *S*s who responded overtly to the training programs scored significantly higher than the *S*s who responded covertly ($p < .10$).

Tentative hypotheses about learning in kindergarten children were presented: that the presence of a non-interacting peer is not a strong incentive for improving learning using programmed instruction, that children can learn a task by observing others respond overtly to that task but not learn as much as the overt responders, that when children interact with peers in a learning situation the amount of learning will decrease, and that programmed instruction is an effective means of teaching kindergarten children a sight vocabulary.

Beatrice Moosally: *The Effects of Delayed Reinforcement in Programmed Instruction with Kindergarten Children.*

This doctoral dissertation is not yet completed, so it will be reported very briefly.

The purpose of the study was to determine the effects of delay of reinforcement upon learning rate and retention in young, normal kindergarten children.

Sixty children were grouped on the basis of sex and ability level (high and average). The 20 subjects for each of the three treatments were selected randomly from each group. The task was to learn 24 nouns with HUMID under three treatment conditions. These were varying lengths of temporal delay of reinforcement: 1: 0-second delay, 2: a 2-second delay, 3: a 4-second delay of reinforcement.

The essential finding was that the delay of reinforcement lights in the HUMID mode of presentation did not effect learning differentially. The data were also analyzed for the relationship of delay to sex and ability.

Howard Bird: *The Facilitation of Beginning Word Recognition Learning as a Function of Three-Dimensional Print.*

This doctoral dissertation is not yet completed, so it will be reported very briefly.

The purpose of the study was to determine if the addition of depth to letters will facilitate children's progress in beginning reading. There is evidence from experimental psychology that two-choice discrimination learning is greatly facilitated when using three-dimensional objects rather than two-dimensional figures. There has also been research demonstrating that the difference between these two modes of presentation is retained if we compare the photographs of three-dimensional objects with two-dimensional patterns. This study compared word recognition learning of printed words with the photographed words made up of three-dimensional letters, the third dimension being revealed by the shading effects.

A sample of 24 kindergarten children were taught 20 sight words by the two methods. The order effect was controlled by having half of the children learn the two-dimensional words first, the other half learned the three-dimensional words first. All teaching was done with HUMID I.

The main finding of this study was that three-dimensional print was definitely superior to two-dimensional. There was, however, an order effect, in that for the children who learned the three-dimensional words first, the difference in learning between the two modes increased dramatically.

It would appear that if three-dimensional print is to be utilized, it should be introduced from the very beginning of reading instruction.

CHAPTER IV

DISCUSSION, CONCLUSIONS AND IMPLICATIONS

The present study must be viewed primarily within the framework of innovation in educational methodology. An instructional system has been designed, accompanying instructional materials have been developed, and it has been tried out three times in three different versions. The results of these studies must be interpreted not only in terms of test scores, error counts, response delays, etc., but also in terms of the much broader questions at hand, such as the feasibility of the system, acceptance and motivation by the children, and other fundamental issues.

In regard to the latter, broader type problem, the experimental results and observations of the children working within this system over prolonged periods has demonstrated that a fully automated system for beginning reading instruction can be developed for use with deaf children. Hardware can be built which is suitable for such children; it would appear that the development of suitable software was by far the greatest difficulty encountered in this project. After three major revisions, it appears that a good beginning has been made toward the development of a fully automated instructional system for teaching beginning reading.

Before discussing the experimental results, a word should be said about the evaluation of learning. The HUMID system accumulates data on both accuracy and response delay for each frame. Several studies in this project have evaluated response delay as a way of measuring learning, and every time the same conclusion was reached: The measurement of response delay contributes very little toward the evaluation of pupil performance. The most thorough study of the different ways of evaluating learning within the present study was done in the dissertation by McClard (1966), who concluded that a simple count of the total number of responses made to a given program was probably the best single measurement of learning. Considering the fact that the data recorder which yields a printed record of response delay for each frame comes at a high cost in time and money, this finding is a great pratical significance.

The data from the third study are somewhat inconclusive but there are many reasons why this is so. First of all, the system was designed for beginning reading instruction, to be used at the beginning of the school year. The study was done at the end of the year. At this time most of the children has learned the concepts taught in the HUMID programs. Also, the duration of about 10 minutes a day for 6 weeks is not enough time to reveal pronounced changes in the children. Thirdly, the HUMID posttest, although appropriate for the concepts taught in the programs, was much too easy for all the children. The Stanford Achievement Test was perhaps as inappropriate, since the curriculum of these children is markedly different from that of the children upon whom the test was standardized.

The HUMID programs which were used in the third study seemed to be more appropriate for the typical deaf first grader than the deaf 9- or 10-year-old in need of remedial instruction. This might, however, merely reflect the fact that the programs were designed for the former group. Programs could, no doubt, be developed which would be designed for remedial instruction with deaf children.

The most important and most significant conclusion drawn from the entire project was that the development of reading skills and the necessary language concept to go with these skills will require an almost unbelievable amount of programming. The Project HUMID staff has estimated that to bring deaf children up from beginning reading to a point of almost complete self-sufficiency in reading (about fourth grade reading level) will require in excess of 800 programs of 30-40 frames each. Such an instructional system must, however, also be accompanied by a systematic program of language development.

The last point made is particularly pertinent when it comes to a discussion of the implications of the present study. This project has revealed that an automated system of non-oral reading instruction can be developed successfully. The environment of deaf children should be saturated with large quantities of verbal, abstract experiences in great variety. The teaching machine is uniquely well equipped to do so with the printed word , and it has a place in every classroom for deaf children; if not as the basic system of teaching reading, at least as a system of supplemental reading instruction.

The project staff considered the present study to be an extremely valuable contribution to deaf education. Similar projects in other phases of language instruction for deaf children should be supported. But the time must also come when the researchers get together to attempt to coordinate their efforts into a cohesive and comprehensive language program for deaf children. Fortunately, several successful attempts have been made by various branches of the Department of Health, Education and Welfare to arrange research conferences for people who are doing research and experimentation with deaf children. This is a short step in the right direction. The problems of language acquisition and cognition in deaf children are so extensive and so complex that a concerted effort of scholars from a variety of related disciplines will be required to make appreciable progress. Individual, independent studies make useful contributions, but i is perhaps the persistent efforts of dedicated researchers, working over a period of several years, which will eventuate in significantly improved comprehensive education for deaf children.

CHAPTER V

SUMMARY

A research project was initiated to develop an essentially new system of teaching beginning reading to hearing impaired children. The method developed was essentially non-oral in nature, in that all instruction was done through visual presentations. The children received no auditory in-put whatever. All instructional material was on 35 mm. slides presented on the rear projection screen of a specially designed teaching machine which also had a response system for the children.

The project had three rather distinct aspects: First, a suitable teaching machine had to be designed and built; secondly, appropriate programs had to be written; and thirdly, the entire instructional system needed experimentation with deaf children.

Two teaching machines were developed during this project, the latter one being the result of experimentation with the first. The machine was conceived of by the principal investigator, but engineered and built by Honeywell, Inc. The machine, Honeywell University of Minnesota Instructional Device (HUMID) has an upper stimulus area and three response panels below upon which three responses can be projected. The machine also has attached to it an automatic data recorder which is a print-out device. This print-out device collects data on the accuracy and the delay of each individual response. Experimentation with various methods of evaluating the learning of children working with this machine revealed that data on response delays have very limited usefulness when studying reading in the teaching machine mode. The recording system is, of course, invaluable as a tool for the study of individual frames and programs. The main conclusion drawn from the work with the machine was that a machine can be constructed with which deaf 5 year-olds can be taught to read.

During the course of the 32 months of the project three sets of programs were developed and studied. These programs employed a variety of programming techniques as well as some new approaches, such as the use of color coding to achieve phonetic consistency in the words used. Certain additional techniques were also employed, such as depth of field of the visual display, motivational devices, etc. Because of the innovative nature of the instructional system, this has been explained in considerable detail in the main body of the report.

Three studies were carried out with the three sets of programs. The first study was exploratory in nature, but indicated that the approach itself was sound and feasible.

The second study revealed that the new machine was appropriate, although the programs were still somewhat steep for these children. The data from the response latencies indicated that as frames become more difficult response latencies increase; also, as additional distractors are introduced, response latencies increase. Those children who were relatively slow in responding to a frame tended to respond with a higher degree of accuracy. Response latencies correlated .56 with the posttest scores, significant at the .10 level. A correlation between IQ and posttest scores of .46 was also found, although this was not a statistically significant correlation. No sex differences could be discerned among the subjects studied.

The third study involved two experimental groups and two control groups. One experimental group consisted of ten first graders, the other experimental group consisted of ten 9-and 10-year-olds who were enrolled in a remedial type class. The control groups were similar to the experimental groups, the groups being equated for IQ, age, sex, degree of hearing handicap and language performance. The experimental children were taught 34 programs over a period of 35 days. All groups were tested at the end with a special test covering the concepts of the programs, as well as the Word Reading and Paragraph Meaning subtests of the Stanford Achievement Test, Primary I. The study of a variety of measures of learning did not reveal any statistically significant differences between the two experimental groups, although the older group performed consistently better than the younger group. On the HUMID posttest the younger experimental group performed better than its control group, the difference being significant at the .01 level. The older experimental group also did better than its control group although the difference failed to reach a level which was statistically significant. On both subtests of the Stanford Achievement Test it was again found that the younger experimental group surpassed their controls at a level which approached significance. There were not, however, any statistically significant differences between the older experimental group and its control.

Five studies were carried out by graduate students within this project. These are described in some detail in the report.

The most important and most significant conclusion drawn from the entire project was that the development of reading skills and the necessary language concept to go with these skills will require an almost unbelievable amount of programming. The Project HUMID staff has estimated that to bring deaf children up from beginning reading to a point of almost complete self-sufficiency in reading (about fourth grade reading level) will require in excess of 800 programs of 30-40 frames each. Such an instructional system must, however, also be accompanied by a systematic program of language development.

The last point made is particularly pertinent when it comes to a discussion of the implications of the present study. This project had revealed that an automated system of non-oral reading instruction can be developed successfully. The environment of deaf children should be saturated with large quantities of verbal, abstract experiences in great variety. The teaching machine is uniquely well equipped to do so with the printed word and it has a place in every classroom for deaf children.

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APPENDIX A

PROGRAMMING TECHNIQUES AND OBJECTIVES FOR THE FIRST STUDY

Before outlining the instructional objectives of the first study, the programming techniques used in this study are described and enumerated in their order of presentation. These techniques are referred to by number in the outline of instructional objectives.

Programming Techniques for the First Study

1. One choice figure matching: A colored geometric shape appears in the stimulus portion of the frame. The same figure appears on a response panel.

2. Two choice figure matching: A colored geometric shape appears in the stimulus portion of the frame. The same figure appears on a response panel. A figure of either a different color or shape appears as a distractor on another response panel.

3. Three choice figure matching: A colored geometric shape appears in the stimulus portion of the frame. The same figure appears on a response panel. Two figures of either different colors or shapes appear as distractors on other response panels.

4. Four choice figure matching: A colored geometric shape appears in the stimulus portion of the frame. The same figure appears on a response panel. Three figures of either different colors or shapes appear as distractors on other response panels.

5. One choice letter matching: A single letter or letter combination appears in the stimulus portion of the frame. The same letter or letter combination appears on a response panel.

6. Two choice letter matching: A single letter or letter combination appears in the stimulus portion of the frame. The same letter or letter combination appears on a response panel. A different letter or letter combination appears as a distractor on another response panel.

7. Three choice letter matching: A single letter or letter combination appears in the stimulus portion of the frame. The same letter or

letter combination appears on a response panel. Two different letters or letter combinations appear as distractors on other response panels.

8. Four choice letter matching: A single letter or letter combination appears in the stimulus portion of the frame. The same letter or letter combination appears on a response panel. Three different letters or letter combinations appear as distractors on other response panels.

9. One choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel.

10. Two choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel. A different word appears as a distractor on another response panel.

11. Three choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel. Two different words appear as distractors on other response panels.

12. Four choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel. Three different words appear as distractors on other response panels.

13. Four choice blank: An illustration appears with a blank in the stimulus portion of the frame. The word that corresponds to the illustration appears on a response panel. Three different words appear as distractors on other response panels.

14. One choice phrase or sentence matching: An illustration appears with a phrase or sentence in the stimulus portion of the frame. The same phrase or sentence appears on a response panel.

15. Four choice one picture phrase: A phrase appears in the stimulus portion of the frame with a picture replacing either the first or last word in the phrase. The complete phrase appears on a response panel. Three incorrect choices appear as distractors on other response panels.

16. Four choice two picture phrase: A phrase appears in the stimulus portion of the frame with a picture replacing the first and last words in the phrase. The complete phrase appears on a response

panel. Three incorrect choices appear as distractors on other response panels.

17. Two choice phrase or sentence matching: An illustration appears with a phrase or sentence in the stimulus portion of the frame. The same phrase or sentence appears on a response panel. A different phrase or sentence appears as a distractor on another response panel.

18. One choice blank; phrase or sentence: An illustration appears with a blank in the stimulus portion of the frame. The phrase or sentence that corresponds to the illustration appears on a response panel.

19. Three choice blank; phrase or sentence: An illustration appears with a blank in the stimulus portion of the frame. The phrase or sentence that corresponds to the illustration appears on a response panel. Two different phrases or sentences appear as distractors on other response panels.

20. Four choice blank; phrase or sentence: An illustration appears with a blank in the stimulus portion of the frame. The phrase or sentence that corresponds to the illustration appears on a response panel. Three different phrases or sentences appear as distractors on other response panels.

21. One choice broken phrase: An illustration appears with a phrase in the stimulus portion of the frame. A blank replaces the first part of the phrase. That part appears on a response panel.

22. Two choice broken phrase: An illustration appears with a phrase in the stimulus portion of the frame. A blank replaces the first part of the phrase. That part appears on a response panel. An incorrect choice appears as a distractor on another response panel.

23. Three choice broken phrase: An illustration appears with a phrase in the stimulus portion of the frame. A blank replaces the first part of the phrase. That part appears on a response panel. Two incorrect choices appear as distractors on other response panels.

24. Four choice broken phrase: An illustration appears with a phrase in the stimulus portion of the frame. A blank replaces either the first or last part of the phrase. That part appears on a response panel. Three incorrect choices appear as distractors on other response panels.

25. Four choice broken phrase; blank in middle: An illustration appears with a five word phrase in the stimulus portion of the frame.

A blank replaces a conjunction in the middle of the phrase. That word appears on a response panel. Three incorrect choices appear as distractors on other response panels.

26. Four choice phrase or sentence matching: An illustration appears with a phrase or sentence in the stimulus portion of the frame. The same phrase or sentence appears on a response panel. Three different phrases or sentences appear as distractors on other response panels.

27. One choice blank: An illustration appears with a blank in the stimulus portion of the frame. A word that corresponds to the illustration appears on a response panel.

28. Three choice blank: An illustration appears with a blank in the stimulus portion of the frame. A word that corresponds to the illustration appears on a response panel. Two different words appear as distractors on other response panels.

Instructional Objectives for the First Study

Program 1

Objective: To develop the ability to discriminate between colored geometric shapes on the basis of color rather than form.

Procedure:

Various geometric shapes of different colors are initially presented. Shape cues are gradually removed until the discrimination of four identical forms of different colors depends solely on color.

Content

blue square, yellow heart, purple triangle, red triangle, green circle, white circle, gray circle

Techniques

Review	New
None	1, 2, 3, 4

Program 2

Objective: To develop the ability to discriminate between colored geometric shapes on the basis of form rather than color and to develop the ability to discriminate between four letters which appear individually and in two letter combinations.

Procedure

Various geometric shapes of different colors are initially presented. Color cues are gradually removed until the discrimination of four identically colored different forms depends solely on shape. Individual letters are then introduced, with the two letter combinations following.

Content

Review	New
Previously introduced colored geometric forms.	Letters: t, e, a, l Letter Combinations: te, al

Techniques

Review	New
1, 2, 3, 4	5, 6, 7, 8

Program 3

Objective: To introduce four sight vocabulary words.

Procedure

Each word is introduced with three or more descriptive illustrations.

Vocabulary

Review	New
None	cat, coat, dog, dress

Illustrations

Review	New
None	cat 1, 2, 3 coat 1, 2, 3, 4 dog 1, 2, 3 dress 1, 2, 3

Techniques

Review	New
None	9, 10, 11, 12

Program 4

Objective: To test the acquisition of the four sight vocabulary words introduced in the preceding program.

Procedure

To select the correct response from four response alternatives for a stimulus illustration without a label.

Vocabulary

Review	New
cat, coat, dog, dress	None

Illustrations

Review	New
cat 1, 2, 3	None
coat 1, 2, 3, 4	
dog 1, 2, 3	
dress 1, 2, 3	

Techniques

Review	New
12	13

Program 5

Objective: To introduce five sight vocabulary words and to review previously learned vocabulary.

Procedure

Each new word is introduced with descriptive pictures. The review frames constitute 20 per cent of the program and the review words are used as distractors.

Vocabulary

Review	New
cat, coat, dog, dress	ball, bat, car, drum, flag

Illustrations

Review	New
cat 1, coat 2	ball 1, 2, 4
dress 1, 2	bat 1, 2, 3, car 4
	drum 1, 2, 3, 4
	flag 1, 2, 3, 4

Techniques

Review	New
9, 10, 11, 12	

Program 6

Objective: To test the acquisition of the five sight vocabulary words introduced in the preceding program.

Procedure

To select the correct response from four response alternatives for a stimulus illustration without a stimulus word.

Vocabulary

Review	New
ball, bat, car, cat, coat, dog, dress, drum, flag	None

Illustrations

Review	New
ball 2, 4 bat 1, 2, 3 car 4 cat 1, 3 dog 1, 2 dress 2 drum 1, 2, 3, 4 flag 1, 3, 4	None

Techniques

Review	New
12, 13	None

Program 7

Objective: To introduce two sight vocabulary words and a conjunction. To review previously learned vocabulary.

Procedure

The sight vocabulary words are introduced with three or more descriptive illustrations. Review words serve as distractors. The conjunction is introduced between two learned words. A new technique is used to focus attention on specific parts of the phrase formed by the conjunction and the other words.

Vocabulary

Review	New
ball, bat, car	and, box, string
coat, dog, dress	
drum, flag	

Illustrations

Review	New
ball 5, bat 5, cat, 5	box 1, 2, 3
coat 5, dress, 3, 5	string 1, 2, 3, 5
drum 5, dog 5, flag 5	

Techniques

Review	New
9, 12, 13	14, 15, 16

Program 8

Objective: To introduce an article and to review previously learned vocabulary.

Procedure

The article is introduced incidentally in connection with review words, in two word phrases. These two word phrases are then used to complete larger phrases.

Vocabulary

Review	New
and, ball, bat, box	the
car, cat, coat, dress	
drum, dog, flag, string	

Illustrations

Review	New
ball 3, 5	None
bat 1, 5	
box 1, 2, 3	
car 4	
cat 1, 2, 5	
coat 2, 5	
dress 1, 3, 5	
drum 1, 5	
dog 1, 3, 5	
flag 3, 5	
string 4, 5	

Techniques

Review	New
14	17, 18, 19, 20, 21, 22, 23, 24

Program 9

Objective: To introduce a preposition and to review previously learned vocabulary.

Procedure

The preposition is introduced incidentally in connection with review words, in three word phrases. These three word phrases are then used to complete larger phrases.

Vocabulary

Review	New
and, ball, bat, box car, cat, coat, dress drum, dog, flag, string the	in

Illustrations

Review	New
ball 2, 3, bat 1, 3 box 1, 2, 3, car 4 cat 2, 3, 5, coat 2 dress 1, 2, drum 4, 5 dog 1, 2, flag 3, 5 string 1, 5	None

Techniques

Review	New
14, 17	25, 26

Program 10

Objective: To introduce three proper nouns and to provide a review of previously learned vocabulary.

Procedure

Each word is introduced with three descriptive pictures. The review words serve as distractors. Incomplete phrases are used in the stimulus portion of the frame, with a variety of response alternatives available for its completion.

Vocabulary

- Review
  - and, ball, bat
  - car, cat, coat
  - dress, drum, dog
  - flag, in, string, box
- New
  - Ben, Pat, Sam

Illustrations

- Review
  - ball 5
  - dog 2
- New
  - Ben 1, 2, 3
  - Pat 1, 2, 3
  - Sam 1, 2, 3

Techniques

- Review
  - 9, 10, 11, 12
  - 13, 22, 23, 26
- New
  - 27, 28

APPENDIX B

PROGRAMMING TECHNIQUES AND OBJECTIVES FOR THE SECOND STUDY

Before outlining the instructional objectives of the second study, the programming techniques used in this study are described and enumerated in their order of presentation. These techniques are referred to by number in the outline of instructional objectives.

1. One choice picture matching: A picture appears in the stimulus portion of the frame. The same picture appears on a response panel.

2. Two choice picture matching: A picture appears in the stimulus portion of the frame. The same picture appears on a response panel. A different picture appears as a distractor on another response panel.

3. Three choice picture matching: A picture appears in the stimulus portion of the frame. The same picture appears on a response panel. Two different pictures appear as distractors on other response panels.

4. One choice word matching: A word appears in the stimulus portion of the frame. The same word appears on a response panel.

5. Two choice word matching: A word appears in the stimulus portion of the frame. The same word appears on a response panel. A different word appears as a distractor on another response panel.

6. Three choice word matching: A word appears in the stimulus portion of the frame. The same word appears on a response panel. Two different words appear as distractors on other response panels.

7. One choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel.

8. Two choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel. A different word appears as a distractor on another response panel.

9. One choice blank: An illustration appears with a blank in the stimulus portion of the frame. A word that corresponds to the illustration appears on a response panel.

10. Two choice blank: An illustration appears with a blank in the stimulus portion of the frame. A word that corresponds to the illustration appears on a response panel. A different word appears as a distractor on another response panel.

11. Three choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel. Two different words appear as distractors on other response panels.

12. Three choice blank: An illustration appears with a blank in the stimulus portion of the frame. The word that corresponds to the illustration appears on a response panel. Two different words appear as distractors on other response panels.

13. One choice sentence matching: An illustration appears with a sentence in the stimulus portion of the frame. The same sentence appears on a response panel.

14. Two choice sentence matching: An illustration appears with a sentence in the stimulus portion of the frame. The same sentence appears on a response panel. A different sentence or word appears as a distractor on another response panel.

15. One choice sentence blank: An illustration appears with a blank in the stimulus portion of the frame. A sentence that corresponds to the illustration appears on a response panel.

16. Two choice sentence blank: An illustration appears with a blank in the stimulus portion of the frame. A sentence that corresponds to the illustration appears on a response panel. A different sentence or word appears as a distractor on another response panel.

17. One choice broken sentence: An illustration appears with a sentence in the stimulus portion of the frame. A blank replaces either the first or last word in the sentence. That word appears on a response panel.

18. Two choice broken sentence: An illustration appears with a sentence in the stimulus portion of the frame. A blank replaces either the first or last word in the sentence. That word appears on a response panel. An incorrect choice appears as a distractor on another response panel.

19. Three choice broken sentence: An illustration appears with a sentence in the stimulus portion of the frame. A blank replaces either the first or last word in the sentence. That word appears on a response panel. Two incorrect choices appear as distractors on other response panels.

20. One choice two sentence stimulus: Two illustrations appear with two sentences in the stimulus portion of the frame. The first sentence is a complete sentence; the second sentence is either replaced by a blank or appears as a broken sentence. The response needed to take the place of the blank or to complete the broken sentence appears on a response panel.

21. Two choice two sentence stimulus: Two illustrations appear with two sentences in the stimulus portion of the frame. The first sentence is a complete sentence; the second sentence is either replaced by a blank or appears as a broken sentence. The response needed to take the place of the blank or to complete the broken sentence appears on a response panel. An incorrect choice appears as a distractor on another response panel.

22. Three choice two sentence stimulus: Two illustrations appear with two sentences in the stimulus portion of the frame. The first sentence is a complete sentence; the second sentence is either replaced by a blank or appears as a broken sentence. The response needed to take the place of the blank or to complete the broken sentence appears on a response panel. Two incorrect choices appear as distractors on other response panels.

23. One choice three sentence stimulus: Two illustrations appear with three sentences in the stimulus portion of the frame. The first two sentences are complete sentences; the third a broken sentence. The response needed to complete the broken sentence appears on a response panel.

24. Two choice three sentence stimulus: Two illustrations appear with three sentences in the stimulus portion of the frame. The first two sentences are complete sentences; the third a broken sentence. The response needed to complete the broken sentence appears on a response panel. An incorrect choice appears as a distractor on another response panel.

25. Three choice broken phrase; blank in middle: An illustration appears with a five word phrase in the stimulus portion of the frame. A blank replaces either a conjunction or a preposition in the middle of the phrase. That word appears on a response panel. Two incorrect choices appear as distractors on other response panels.

Instructional Objectives for the Third Study

Program 1

Objective: To introduce the teaching machine through the use of picture matching and to establish reinforcement conditions.

Content

A variety of pictures were used which were categorized as follows: animals, birds, butterflies; flags, flowers, fruits, toys

Techniques

Review	New
	1, 2, 3

Program 2

Objective: To increase the discrimination needed to make a correct response through the use of stimulus and response pictures of the same categories.

Content

Program 1 pictures

Techniques

Review	New
1, 2, 3	

Program 3

Objective: To develop the ability to discriminate between words.

Procedure

The word matching technique used in this program is similar to the picture matching technique of the preceding programs.

Content

basket, cat, dog, flag

Techniques

Review	New
	4, 5, 6

Program 4

Objective: To introduce two sight vocabulary words.

Procedure

Each new word is introduced with four descriptive illustrations.

Vocabulary

Review	New
	cat, dog

Illustrations

Review	New
	cat 1, 2, 3, 4
	dog 1, 2, 3, 4

Techniques

Review	New
	7, 8, 9, 10

Program 5

Objective: To introduce two proper nouns and to review previously learned vocabulary.

Procedure

Each new word is introduced with five descriptive illustrations. Review vocabulary serves as distractors.

Vocabulary

Review	New
cat, dog	Ben, Pat

Illustrations

Review	New
cat 1, 2, 3, 4	Ben 1, 2, 3, 4, 5
dog 1, 2, 3, 4	Pat 1, 2, 3, 4, 5

Techniques

Review	New
7, 8, 9, 10	11, 12

Program 6

Objective: The concept runs is introduced in the context Ben runs. and Pat runs.

Procedure

Ben runs. and Pat runs. are initially introduced as a sentence. Later a blank is used in place of the stimulus sentence and finally the sentence is broken so that either ______ runs. or Ben _______. or Pat ______. appears in the stimulus position.

Vocabulary

Review	New
cat, dog, Ben, Pat	runs

Illustrations

Review	New
cat 2	None
dog 4	
Ben 2, 3, 4, 5	
Pat 2, 3, 4, 5	

Techniques

Review	New
8, 11	13, 14, 15, 16, 17, 18

Program 7

Objective: The article a is introduced in the context a cat and a dog, and the article the is introduced in the context the dog runs. and the cat runs.

Procedure

The stimulus phrases a cat and a dog are later replaced by a blank in the stimulus position. The stimulus the dog runs. and the cat runs. are initially introduced as a sentence, then broken so that either the dog _______. or _____ _____ runs appears in the stimulus position. Subjects are not required to distinguish between the articles, but they are required to discriminate between the dog runs. and the cat runs.

Vocabulary

Review	New
cat, dog, Ben, Pat, runs	a, the

Illustrations

Review	New
cat 2, 3	*Sam 1, 2, 3, 4, 7
dog 1, 3, 4	dog 8, 9
Ben 3, 4, 5	
Pat 3, 4,5	

*a cat with a proper name

Techniques

Review	New
7, 8, 9, 10, 11, 12	17, 18, 19

Program 8

Objective: To introduce sits in the context Ben sits., Pat sits., the dog sits., and the cat sits.

Procedure

The four new sentences are introduced with descriptive illustrations. Later a blank replaces sits and the correct response must be chosen from the choices sits and runs.

Vocabulary

Review	New
a cat, a dog	Ben sits.
Ben, Pat,	Pat sits.
Ben runs.	the cat sits.
Pat runs.	the dog sits.
the cat runs.	
the dog runs.	

Illustrations

Review	New
cat 3, dog 1, 9	cat 8, 9
Ben 2, 3, 4, 5	dog 10
Pat 2, 3, 4 , 5	Ben 12, 13
	Pat 11, 12

Techniques

Review	New
7, 13, 15, 16, 17, 18, 19	None

Program 9

Objective: The conjunction and is introduced in the context Pat and Ben, Ben and Pat, Ben and the cat, Pat and the cat, Ben and the dog, Ben and a dog, the cat and the dog, and the cat and a dog.

Procedure

A complete phrase is introduced in the stimulus section with two descriptive illustrations appearing with each phrase. Later a blank is used in place of the stimulus phrase and finally the phrase is broken in the stimulus position.

Vocabulary

Review

cat, dog, Ben, Pat, the cat, the dog, a dog, the dog runs., the cat runs.

New

Pat and Ben
Ben and Pat
Ben and the cat
Pat and the cat
Ben and the dog
Ben and a dog
the cat and the dog
the cat and a dog

Illustrations

Review

cat 1
dog 1, 4
Ben 2, 5
Pat 2, 5
Sam 1

New

cat 6
Ben 1
Pat 1
Sam 8, 12, 13

Techniques

Review

13, 14, 15, 16, 17, 18, 19

New

Program 10

Objective: To present two lines of print in the stimulus portion of the frame.

Procedure

Two review sentences are presented simultaneously in the stimulus. Each sentence combination appears with a variety of two descriptive illustrations. A blank is substituted for either the first or last part of the second sentence, or for the entire second sentence, e.g.

Pat runs
the dog ______.

the dog runs.
______ sits.

Ben runs.
____ ____ ____.

Vocabulary

Review

the cat, the dog, Ben, Pat, the cat runs., the dog runs., Ben runs., Pat runs., the cat sits., the dog sits., Ben sits., Pat sits.

New

Illustrations

Review

cat 8, dog 8
Ben 3, 4, 5, 13
Pat 3, 4, 5, 12
Sam 4, 12, 13

New

dog 11, 12, 16

Techniques

Review

13, 16, 18

New

20, 21, 22

Program 11

Objective: To introduce run in the context Pat and Ben run., Ben and Pat run., the cat and the dog run., the dog and the cat run., and to introduce sit in the context of the above.

Procedure

Variant forms of run and sit have been previously learned in grammatically correct context. Subjects are not asked to distinguish between the two forms of each verb. Three sentences are presented simultaneously in the stimulus portion of the frame with two descriptive illustrations. The third sentence is broken and the correct response appears alone in the response position.

Vocabulary

Review

Pat, Ben
Pat and Ben
Ben sit., Pat sits.
Ben runs., Pat runs.
the cat, the dog
the cat and the dog
the cat sits., the dog sits.
the cat runs., the dog runs.

New

run, sit

Illustrations

Review

cat 1, 6, 9
Sam 3, 4, 12
dog 8, 9, 10, 11
Ben 1, 2, 4, 5, 13
Pat 1, 2, 3, 4, 5, 11, 12

New

cat 12

Techniques

Review

15, 16, 17, 18, 19

New

23

Program 12

Objective: To introduce two sight vocabulary words, table and chair, and to join them in a phrase with the conjunction and.

Procedure

Each new word is introduced with three descriptive illustrations. A variety of techniques are used with each word and later they are joined in the phrase a table and a chair and the chair and the table.

Vocabulary

Review	New
and, a cat, a dog the cat, the dog, run runs, sit, sits, Ben Pat	chair, table

Illustrations

Review	New
cat 3, 4	chair 1, 2, 3
dog 1	table 1, 2, 3
Ben 2, 3, 4, 13	
Pat 2, 3, 4, 12	

Techniques

Review	New
7, 9, 10, 11, 12, 18, 19, 21, 22	24, 25

Program 13

Purpose: To introduce the preposition on in the context Pat sits on the chair., Pat sits on the table., Ben sits on the chair., Ben sits on the table., and the cat sits on the chair.

Procedure

Familiar phrases provide the context for the introduction of the preposition. Various techniques are utilized to provide experiences with its use.

Vocabulary

Review	New
a cat, the cat, a dog the dog, the cat sits, Ben, Pat, Ben sits, Pat sits, the chair, the table	on

Illustrations

Review

Ben 2, 12, 13
Pat 2, 11, 12
Sam 1, 2
chair 1, 2, 3
table 1

New

Ben 14, Pat 13
Sam 14

Techniques

Review

12, 15, 16
17, 18, 19

New

26

Program 14

Objective: To introduce the preposition *under* in the context *Ben sits under the table.*, *Pat sits under the table.* and *the cat sits under the table.*

Procedure

Familiar phrases provide the context for the introduction of the preposition. Various techniques are utilized to provide experience with its use. Subjects are required to discriminate between *on* and *under* on the basis of illustration alone.

Vocabulary

Review

a cat, Ben, Pat
Ben sits., Pat sits.
the cat sits , the table
the chair, on the table
on the chair

New

under

Illustrations

Review

Ben 2, 12, 14
Pat 2, 11, 12, 13
cat 3, 9, 11

New

Ben 15
Pat 14
cat 11, 13

Techniques

Review

15, 16, 17, 18, 19

New

27

APPENDIX C

PROGRAMMING TECHNIQUES AND OBJECTIVES FOR THE THIRD STUDY

Before outlining the instructional objectives of the third study, the programming techniques used in this study are described and enumerated in their order of presentation. These techniques are referred to by number in the outline of instructional objectives.

1. One choice picture matching: A picture appears in the stimulus portion of the frame. The same picture appears on a response panel.

2. Two choice picture matching: A picture appears in the stimulus portion of the frame. The same picture appears on a response panel. A different picture appears as a distractor on another response panel.

3. Three choice picture matching: A picture appears in the stimulus portion of the frame. The same picture appears on a response panel. Two different pictures appear as distractors on other response panels.

4. One choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel.

5. Two choice matching: An illustration appears with a word in the stimulus portion of the frame. The same word appears on a response panel. A different word appears as a distractor on another response panel.

6. One choice blank: An illustration appears with a blank in the stimulus portion of the frame. A word that corresponds to the illustration appears on a response panel.

7. Two choice blank: An illustration appears with a blank in the stimulus portion of the frame. A word that corresponds to the illustration appears on a response panel.

8. One choice sentence matching: An illustration appears with a three word sentence in the stimulus portion of the frame. The same sentence appears on a response panel.

9. One choice sentence blank: An illustration appears with a blank in the stimulus portion of the frame. The three word sentence that corresponds to the illustrations appears on a response panel.

10. Two choice sentence matching: An illustration appears with a three word sentence in the stimulus portion of the frame. The same sentence appears on a response panel. A different sentence or word appears as a distractor on another response panel.

11. Two choice sentence blank: An illustration appears with a blank in the stimulus portion of the frame. The three word sentence that corresponds to the illustration appears on a response panel. A different sentence or word appears as a distractor on another response panel.

12. Three choice word or sentence matching: An illustration appears with a word or sentence in the stimulus portion of the frame. The same word or sentence appears on a response panel. Two different word or/and sentences appear as distractors on other response panels.

13. Three choice word or sentence blank: An illustration appears with a blank in the stimulus portion of the frame. The word or sentence that corresponds to the illustration appears on a response panel. Two different words or/and sentences appear as distractors on other response panels.

14. Two choice blank; simultaneous presentation of colors yellow and blue. Two identical rectangles of yellow and blue appear in the stimulus portion of the frame. Under one rectangle the appropriate color word is given; under the other rectangle is a blank. The correct response for the blank must be chosen from the word choices yellow andblue and review vocabulary, which appear on response panels.

15. Two choice broken phrase; blank in middle: The illustration in the stimulus portion of the frame is either a yellow box or a blue box; a ______ box appears under the illustration. The correct response for the blank must be chosen from the word choices yellow and blue, which appear on two response panels.

Instructional Objectives for the Third Study

Program 1

Objective: To introduce the teaching machine through the use of picture matching and to establish reinforcement conditions.

Content

A variety of pictures were used which were categorized as follows: animals, birds, butterflies, flags, flowers, fruits, toys

Techniques

Review	New
	1, 2, 3

Program 2

Objective: To increase the discrimination needed to make a correct response through the use of stimulus and response pictures of the same categories.

Content

Program 1 pictures

Techniques

Review	New
2, 3	

Program 3

Objective: To introduce the concepts *Janet* and *Ben,* and to develop an appropriate response to two programming techniques.

Procedure

Each of the new words is introduced with a descriptive illustration. Stimulus *Janet* appears with *Ben* as a distractor and stimulus *Ben* appears with *Janet* as a distractor.

Vocabulary

Review	New
	Janet Ben

Illustrations

Review	New
	Janet 1 Ben 1

Techniques

Review	New
	4, 5

Program 4

Objective: To further develop the concepts Janet and Ben through the use of two new techniques.

Procedure

The new techniques are introduced as an extension of the familiar techniques of the preceding program.

Vocabulary

Review	New
Janet, Ben	None

Illustrations

Review	New
Janet 1, Ben 1	None

Techniques

Review	New
4, 5	6, 7

Program 5

Objective: To further develop the concepts Janet and Ben with new illustrations.

Procedure

Concepts are reviewed with familiar illustrations and techniques, and extended to two new illustrations.

Vocabulary

Review	New
Janet, Ben	None

Illustrations

Review	New
Janet 1, Ben 1	Janet 2, Ben 2

Techniques

Review	New
4, 5, 6, 7	None

Program 6

Objective: To introduce the concept sitting within the context Ben is sitting.

Procedure

The concept Ben is reviewed and Ben is sitting. is introduced with two new illustrations.

Vocabulary

Review	New
Ben	Ben is sitting.

Illustrations

Review	New
Ben 1, 2	Ben 13, 26

Techniques

Review	New
4, 5, 6, 7	8, 9

Program 7

Objective: To expand the concept sitting by introducing Janet is sitting.

Procedure

The concept Janet is reviewed and Janet is sitting. is introduced with two new illustrations.

Vocabulary

Review	New
Janet	Janet is sitting.

Illustrations

Review	New
Janet 1, 2	Janet 12, 23

Techniques

Review	New
4, 5, 6, 7, 8, 9	10, 11

Program 8

Objective: To further develop the concept Janet is sitting. through the introduction of a new technique and by comparing Janet is sitting. with Ben is sitting.

Procedure

Janet is sitting. has Ben is sitting. as a distractor.

Vocabulary

Review	New
Janet, Ben Janet is sitting. Ben is sitting.	None

Illustrations

Review	New
Janet 1, 2, 12, 23	None

Techniques

Review	New
4, 5, 6, 7, 8, 9, 10, 11	12

Program 9

Objective: To further develop the concept Ben is sitting. through the introduction of a new technique and by comparing Ben is sitting. with Janet is sitting.

Procedure

Stimulus Ben is sitting. has Janet is sitting. as a distractor.

Vocabulary

Review	New
Janet, Ben Janet is sitting. Ben is sitting.	None

Illustrations

Review	New
Ben 1, 2, 13, 26	None

Techniques

Review	New
4, 5, 6, 7, 8 9, 10, 11, 12	13

Program 10

Objective: To introduce the concept a cat.

Procedure

Stimulua a cat has Janet and Ben as distractors.

Vocabulary

Review	New
Janet, Ben	a cat

Illustrations

Review	New
Janet 1, Ben 1	cat 3, *Sam 7

Techniques

Review	New
4, 5, 6, 7, 12, 13	None

Program 11

Objective: To further develop the concept a cat with new illustrations and through comparisons of Janet is sitting, and Ben is sitting. with a cat.

Procedure

Stimuli Janet is sitting. and Ben is sitting. have a cat as a distractor.

Vocabulary

Review	New
Janet, Ben a cat, Janet is sitting. Ben is sitting.	None

Illustrations

Review	New
cat 3, Sam 7	cat 2, 4

Techniques

Review	New
4, 5, 6, 7, 10, 11, 12, 13	None

Program 12

Objective: To review all vocabulary, illustrations and concepts. To introduce a sequence format that changes illustrations with every frame and confines the response to two choices.

---

* a cat with a proper name

Procedure

Illustrations are programmed in a sequence of concepts. Distractors are randomly assigned, although no distractor is used erroneously. (e.g. Stimulus Ben is sitting., Response Ben is sitting., Distractor Ben)

Vocabulary

Review	New
Janet, Ben a cat, Janet is sitting. Ben is sitting.	None

Illustrations

Review	New
Janet 1, 2, 12, 23 Ben 1, 2, 13, 26 cat 2, 3, 4 Sam 7	None

Techniques

Review	New
5, 7, 10, 11	

Program 13

Objective: To expand the concept sitting by introducing the cat is sitting. (the is introduced in context).

Procedure

Stimulus the cat is sitting. has Ben and Janet as distractors.

Vocabulary

Review	New
Janet, Ben, a cat	the cat is sitting.

Illustrations

Review	New
cat 3, Sam 7	cat 9, Sam 1

Techniques

Review	New
5, 6, 7, 8, 9, 10, 11, 12	None

Program 14

Objective: To further develop the concept the cat is sitting. by comparing the cat is sitting. with Janet is sitting. and Ben is sitting.

Procedure

Stimulus the cat is sitting. has Janet is sitting. and Ben is sitting. as distractors. Also, stimuli Ben is sitting. and Janet is sitting. have the cat is sitting. as a distractor.

Vocabulary

Review	New
Janet, Ben, a cat	None
Janet is sitting.	
Ben is sitting.	
the cat is sitting.	

Illustrations

Review	New
Janet 23	None
Ben 26	
cat 9, Sam 1	

Techniques

Review	New
8, 9, 10, 11, 12, 13	None

Program 15

Objective: To review all vocabulary, illustrations and concepts within a sequence format.

Procedure

See Procedure, Program 12

Vocabulary

Review	New
Janet, Ben, a cat	
Janet is sitting.	
Ben is sitting.	
the cat is sitting.	

Illustrations

Review	New
Janet 1, 12, 23	
Ben 1, 13, 26	
cat 3, 9	
Sam 1, 7	

Techniques

Review	New
5, 7, 10, 11	

Program 16

Objective: To introduce the concept running in the context Ben is running.

Procedure

The concept Ben is reviewed and Ben is running. is introduced with two new illustrations.

Vocabulary

Review	New
Janet, Ben, a cat	Ben is running.
Janet is sitting.	
the cat is sitting.	

Illustrations

Review	New
Ben 1	Ben 5, 27

Techniques

Review	New
5, 7, 8, 9, 10, 11, 12, 13	

Program 17

Objective: To further develop the concept Ben is running. through additional experience with Ben, Ben is sitting. and Ben is running.

Procedure

Stimuli Ben, Ben is sitting. and Ben is running. have Janet, Janet is sitting., a cat, and the cat is sitting. as distractors.

Vocabulary

Review	New
Janet, Ben, a cat Janet is sitting. the cat is sitting. Ben is running.	None

Illustrations

Review	New
Ben 1, 5, 13, 26, 27	

Techniques

Review	New
5, 8, 9, 10, 11, 12, 13	

Program 18

Objective: To expand the concept of running by introducing Janet is running.

Procedure

The concept Janet is reviewed and Janet is running. is introduced with two new illustrations.

Vocabulary

Review	New
Janet, Ben, a cat Ben is sitting. the cat is sitting.	Janet is running.

Illustrations

Review	New
Janet 1	Janet 24, 25

Techniques

Review	New
5, 7, 8, 9, 10, 11, 12, 13	

Program 19

Objective: To further develop the concept Janet is running. through additional experience with Janet, Janet is sitting. and Janet is running.

Procedure

Stimuli Janet, Janet is sitting. and Janet is running. have Ben, Ben is sitting., a cat, and the cat is sitting. as distractors.

Vocabulary

Review	New
Janet, Ben, a cat	None
Ben is sitting.	
the cat is sitting.	
Janet is running.	

Illustrations

Review	New
Janet 1, 12, 23, 24, 25	None

Techniques

Review	New
5, 8, 9, 10, 11, 12, 13	None

Program 20

Objective: To further develop the concept Janet is running. by comparing Janet is sitting. with Janet is running.

Procedure

Stimulus Janet is running. has Janet is sitting. as a distractor.

Vocabulary

Review	New
Janet, Ben, a cat	None
Janet is sitting.	
the cat is sitting.	
Janet is running.	

Illustrations

Review	New
Janet 1, 12, 23, 24, 25	

Techniques

Review	New
7, 8, 9, 10, 11, 12, 13	

Program 21

Objective: To further develop the concept Ben is running. by comparing Ben is sitting. with Ben is running.

Procedure

Stimulus Ben is running. has Ben is sitting. as a distractor.

Vocabulary

Review	New
Janet, Ben, a cat the cat is sitting. Ben is sitting. Ben is running.	None

Illustrations

Review	New
Ben 1, 5,13, 26, 27	None

Techniques

Review	New
5, 7, 8, 9, 10, 11, 12	None

Program 22

Objective: To compare the concepts Ben is running. and Janet is running.

Procedure

Stimulus Ben is running. has Janet is running. as a distractor.
Stimulus Janet is running. has Ben is running. as a distractor.

Vocabulary

Review	New
Janet, Ben, a cat the cat is sitting. Janet is running. Ben is running.	None

Illustrations

Review	New
Janet 1, 24, 25 Ben 1, 5, 27	None

Techniques

Review	New
4, 5, 6, 7, 8, 9, 10, 11 12, 13	None

Program 23

Objective: To expand the concept running by introducing the cat is running.

Procedure

The concept a cat is reviewed and the cat is running. is introduced with two new illustrations.

Vocabulary

Review	New
Janet, Ben, a cat	the cat is running.
Janet is sitting.	
Ben is sitting.	

Illustrations

Review	New
cat 3, Sam 7	cat 8, Sam 6

Techniques

Review	New
5, 7, 8, 9, 10, 11, 12, 13	None

Program 24

Objective: To further develop the concept the cat is running. through additional experience with it.

Procedure

This program is an extension of Program 23

Vocabulary

Review	New
Janet, Ben, a cat	None
Ben is sitting.	
the cat is running.	

Illustrations

Review	New
cat 3, 8	None
Sam 6, 7	

Techniques

Review	New
5, 7, 8, 9, 10, 11, 12, 13	None

Program 25

Objective: To further develop the concept the cat is running. by comparing the cat is sitting. with the cat is running.

Procedure

Stimulus the cat is running. has the cat is sitting. as a distractor.

Vocabulary

Review	New
Janet, Ben, a cat	None
Janet is sitting.	
Ben is sitting.	
the cat is sitting.	
the cat is running.	

Illustrations

Review	New
cat 3, 8, 9	None
Sam 1, 6, 7	

Techniques

Review	New
5, 7, 8, 9, 10, 11, 12, 13	None

Program 26

Objective: To compare the concepts the cat is running., Ben is running. and Janet is running.

Procedure

Stimulus the cat is running. has Ben is running. or Janet is running. as a distractor. Stimulus Ben is running. has the cat is running. as a distractor. Stimulus Janet is running. has the cat is running as a distractor.

Vocabulary

Review	New
Janet, Ben, a cat	None.
Ben is sitting.	
Janet is running.	
Ben is running.	
the cat is running.	

Illustrations

Review	New
Janet 1, 25	None
Ben 1, 5	
cat 3, 8	
Sam 6	

Techniques

Review	New
5, 7, 8, 9, 10, 11, 12	

Program 27

Objective: To review all vocabulary, illustrations and concepts within a sequence format.

Procedure
See Procedure, Program 12

Vocabulary

Review	New
Janet, Ben, a cat	None
Janet is sitting.	
Ben is sitting.	
the cat is sitting.	
Janet is running.	
Ben is running.	
the cat is running.	

Illustrations

Review	New
Janet 1, 12, 23, 24, 25	None
Ben 1, 5, 13, 26, 27	
cat 3, 8, 9	
Sam 1, 6, 7	

Techniques

Review	New
5, 7, 10, 11	None

Program 28

Objective: To review all vocabulary, illustrations and concepts within a sequence format.

Procedure

This program deals with the same vocabulary and illustrations as Program 27. However, the sequence of concepts is not the same.

Vocabulary

See Vocabulary, Program 27

Illustrations

See Illustrations, Program 27

Techniques

See Techniques, Program 27

Program 29

Objective: To introduce the concept box within the context a box.

Procedure

Stimulus a box with previously learned vocabulary as distractors.

Vocabulary

Review	New
Janet, Ben, a cat	a box
Janet is sitting.	
Ben is running.	

Illustrations

Review	New
Janet 1, 12	box 3, 15
Ben 27	

Techniques

Review	New
4, 5, 6, 7, 8, 10, 11, 12, 13	

Program 30

Objective: To introduce the concept yellow and the concept blue.

Procedure

Stimulus yellow has blue as a distractor. Stimulus blue has yellow as a distractor.

Vocabulary

Review

New

yellow, blue

Illustrations

Review

New

color yellow

color blue

Techniques

Review

4, 5, 6, 7

New

Program 31

Objective: To determine whether identical forms of yellow and blue are being discriminated on the basis of color rather than form.

Procedure

The stimulus part of the frame has two identical rectangles of yellow and blue. Under one rectangle the appropriate color word is given; under the other rectangle is a blank. The appropriate response for this rectangle must be chosen from two or three choices.

Vocabulary

Review

Janet, Ben, a cat
Janet is sitting.
Ben is sitting.
the cat is sitting.
Janet is running.
Ben is running.
the cat is running.
yellow, blue

New

None

Illustrations

Review

colors yellow, blue

New

None

Techniques

Review	New
4, 5, 6, 7	14

Program 32

Objective: To introduce the concept a yellow box and the concept a blue box.

Procedure

The concepts yellow and a box introduce a yellow box. The concepts blue and a box introduce a blue box. Review vocabulary from Programs 3 through 28 serve as distractors.

Vocabulary

Review	New
Janet, Ben, a cat	a yellow box
Janet is sitting.	a blue box
Ben is sitting.	
the cat is sitting.	
Janet is running.	
Ben is running.	
the cat is running.	
yellow, blue	

Illustrations

Review	New
colors yellow, blue	box 13, 14
box 3	

Techniques

Review	New
4, 5, 6, 7, 8, 9, 10, 11, 12, 13	None

Program 33

Objective: To introduce a broken phrase.

Procedure

The illustration in the stimulus part of the frame is either a yellow box or a blue box; a ______ box appears under the illustration. The correct response must be choosen from the choices yellow and blue.

Vocabulary

Review	New
Janet, Ben, a cat	None
Janet is running.	
Ben is sitting.	
a box, yellow, blue	
a yellow box	
a blue box	

Illustrations

Review	New
colors yellow, blue	None
box 3, 13, 14	

Techniques

Review	New
4, 5, 6, 7, 8, 10, 11	15

Program 34

Objective: To determine whether or not the concepts a box, a yellow box, and a blue box, have generalized to three new illustrations depicting those concepts.

Procedure

Familiar illustrations review the concepts a box, yellow, blue, a yellow box, and a blue box throughout the program. New illustrations provide the stimulus for generalizing concepts.

Vocabulary

Review	New
Janet, Ben, a cat	None
Janet is sitting.	
Ben is sitting.	
the cat is sitting.	
the cat is running.	
a box	
a yellow box	
a blue box	

Illustrations

Review	New
colors blue, yellow	box 12, 16, 17
box 3, 13, 14	

Techniques

Review

4, 5, 6, 7, 8,
10, 12, 15

New

None

APPENDIX D

LISTING AND DESCRIPTION OF ILLUSTRATIONS FOR THE PROGRAMS IN SET 3

Illustration	Description
Ball 1	red
Ball 2	white baseball
Ball 3	practice golf ball
Ball 4	green
Ball 5	large baseball
Ball 6	small baseball
Ball 7	basketball in box
Ball 8	small softball
Bat 1	red & white
Bat 2	green, narrow
Bat 3	brown, long
Bat 4	short, rounder
Bat 5	large
Bat 6	with ball in car
Bat 7	in box
Ben 1	standing
Ben 2	head
Ben 3	running right
Ben 4	running left
Ben 5	running forward
Ben 6	behind tree
Ben 7	hiding in car
Ben 8	hiding in box
Ben 9	hand to forehead
Ben 10	looking in car
Ben 11	looking in box
Ben 12	sitting in chair
Ben 13	sitting cross-legged
Ben 14	sitting on table 2
Ben 15	sitting under table 2
Ben 16	sitting at table with box & hat on table

Illustration	Description
Ben 17	sitting at table reading paper
Ben 18	sitting at table folding paper into hat
Ben 19	sitting at table pasting hat together
Ben 20	standing holding finished hat
Ben 21	sitting in chair father made
Ben 22	sitting on car
Ben 23	standing placing box on top of wagon
Ben 24	standing painting box
Ben 25	standing holding hat (black)
Ben 26	Ben sitting-holding knees
Ben 27	Ben running hard-right
Ben 28	Ben running hard-left
Blue	blue sheet large enough to cover stimulus portion of frame.
Box 1	red
Box 2	brown
Box 3	white
Box 4	green
Box 5	brown
Box 6	in car
Box 7	red, closed
Box 8	Box 1 on table 1
Box 9	box 1 under table 1
Box 10	box 2 on chair 3
Box111	Box 4 painted red
Box 12	Box 4 painted cream
Box 13	box 3 shape colored yellow
Box 14	box 3 shape colored blue
Box 15	box 2 without lettering
Box 16	box 4 shape colored yellow
Box 17	box 4 shape colored blue
Car 1	red
Car 2	yellow convertible
Car 3	black
Car 4	green
Car 5	red, toy
Car 6	blue, in box
Cat 1	white angora
Cat 2	orange
Cat 3	many colors

Illustration	Description
Cat 4	white with black spots
Cat 5	in box
Cat 6	with dog
Cat 7	with dog in car
Cat 8	cat 3 running
Cat 9	cat 3 sitting
Cat 10	cat 3 standing
Cat 11	cat 3 sitting on chair 3
Cat 12	cat 3 lying under chair 3
Cat 13	small cat 3
Cat 14	small cat 9
Chair 1	plain wooden
Chair 2	patio
Chair 3	red, armless upholstered
Coat 1	girl's red
Coat 2	lady's blue
Coat 3	yellow raincoat
Coat 4	girl's green
Coat 5	girl's brown
Coat 6	gray in box
Coat 7	with dress in box
Coat 8	blue in car
Dad 1	standing
Dad 2	walking
Dad 3	sitting in chair 2
Dad 4	making chair
Dad 5	sanding chair
Dad 6	painting chair
Dad 8	sitting in lawn chair
Dad 9	putting wheel on toy car
Dad 10	putting steering wheel on car
Dad 11	painting car
Dog 1	black & white
Dog 2	cooker spaniel
Dog 3	dachshund
Dog 4	small black & brown
Dog 5	brown hiding in box
Dog 6	brown, looking in box
Dog 7	brown in car
Dog 8	dog 1 running right
Dog 9	dog 1 running left
Dog 10	dog 1 sitting

Illustration	Description
Dog 11	dog 4 sitting
Dog 12	black and white sitting in broken box on wagon
Dog 13	dog 4 sitting in lawn chair that dad has made sitting on car
Dog 14	sitting on car
Dog 15	dog 4 running
Dog 16	dog 1 running left hand
Dog 17	dog 1 running right hand
Dress 1	girl's red
Dress 2	blue with white dots
Dress 3	orange jumper, white blouse
Dress 4	green evening gown
Dress 5	plaid, long sleeves
Dress 6	lady's evening dress
Dress 7	pink dress in box
Drum 1	red & white
Drum 2	bass for marching band
Drum 3	Indian
Drum 4	green & white
Drum 5	blue and white with animal pictures
Drum 6	large yellow
Drum 7	orange in car
Flag 1	red pennant
Flag 2	American
Flag 3	blue and white checker
Flag 4	green
Flag 5	orange with blue stars
Flag 6	yellow pennant-shape
Flat 7	in car
Flag 8	black & white in box
Hat 1	black
Hat 2	white - ladies
Hat 3	red bonnet with ties
Hat 4	yellow rain
Pat 1	standing
Pat 2	head
Pat 3	running right
Pat 4	running left
Pat 5	running forward
Pat 6	hiding behind tree
Pat 7	hiding in box

Illustration	Description
Pat 8	hiding in car
Pat 9	looking in box
Pat 10	looking in car
Pat 11	sitting on chair
Pat 12	sitting cross-legged
Pat 13	sitting on table 1
Pat 14	sitting under table 1
Pat 15	holding hat 3
Pat 16	sitting at table1 with box & white hat on it
Pat 17	sitting at table 1 with white hat partially made (gluing flowers)
Pat 18	sitting at table 1 putting ribbon on hat
Pat 19	sitting at table finishing ribbon hat
Pat 20	walking with white hat in hand
Pat 21	sitting in lawn chair
Pat 22	sitting on toy car.
Pat 23	sitting-knees up
Pat 24	running-front
Pat 25	running right
Sam 1 *	sitting position
Sam 2	head
Sam 3	running
Sam 4	running
Sam 5	walking
Sam 6	running away
Sam 7	standing
Sam 8	walking left
Sam 9	hiding behind tree
Sam 10	hiding in box
Sam 11	hiding in car
Sam 12	sitting - miniature 1
Sam 13	running right - miniature 4
Sam 14	sitting on chair next to table with box and hat on it
Sam 15	sitting on table with hat and box on it and chair near by
Sam 16	lying under hat on table with box nearby and chair next to table
Sam 17	standing on table next to hat and box on chair nearby

*a cat with a proper name

Illustration	Description
Sam 18	standing on chair next to hat table with box on it near by
Sam 19	running under hat
String 1	red
String 2	white ball
String 3	brown
String 4	green
String 5	brown
String 6	brown - large file
String 7	large - yellow
Table 1	plain wooden
Table 2	patio
Table 3	round living room
Table 4	with box on and chair nearby
Table 5	with box and hat on and chair nearby
Yellow	yellow sheet large enough to cover stimulus portion of frame.

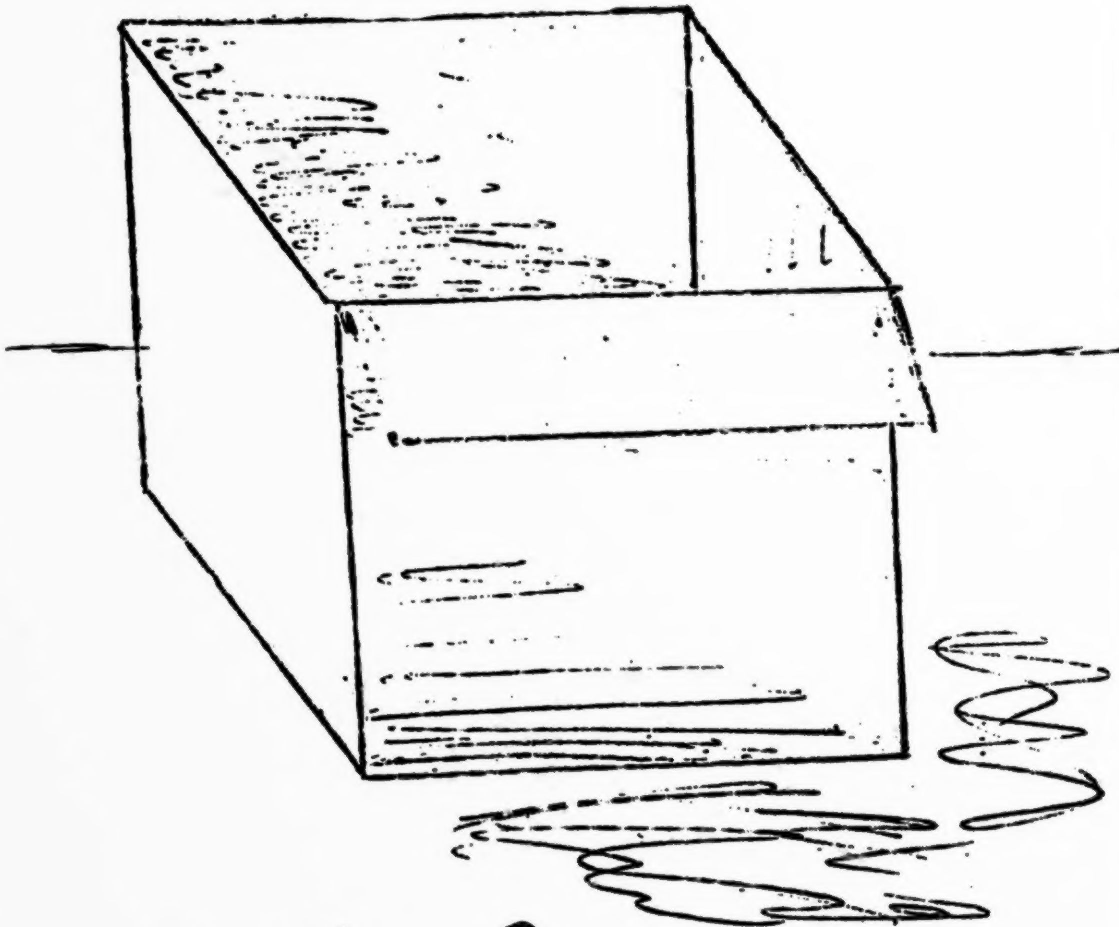
APPENDIX E

Sample pages from HUMID posttest

Name______________ Date__________ Score_

HUMID TEST

Sample A

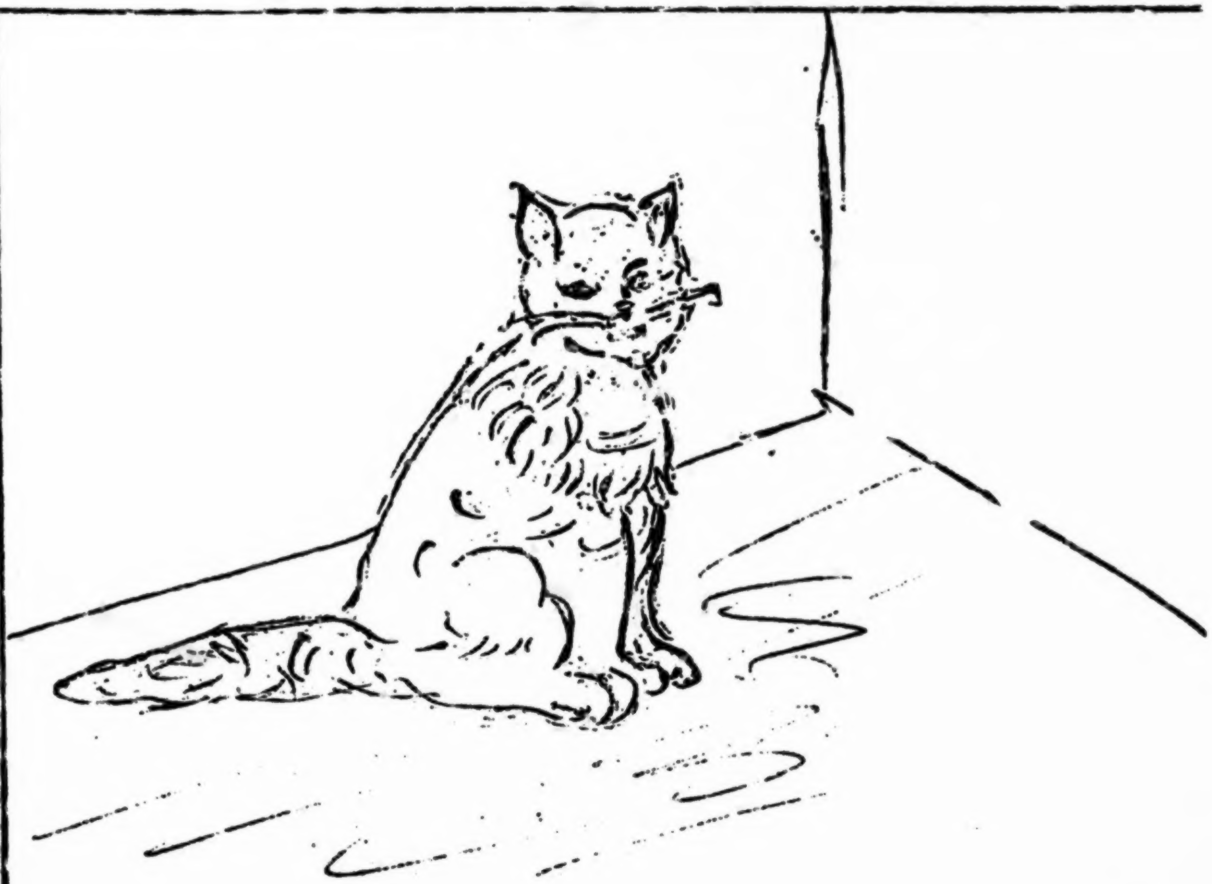


a cat ○

a box ☒

yellow ○

Sample B

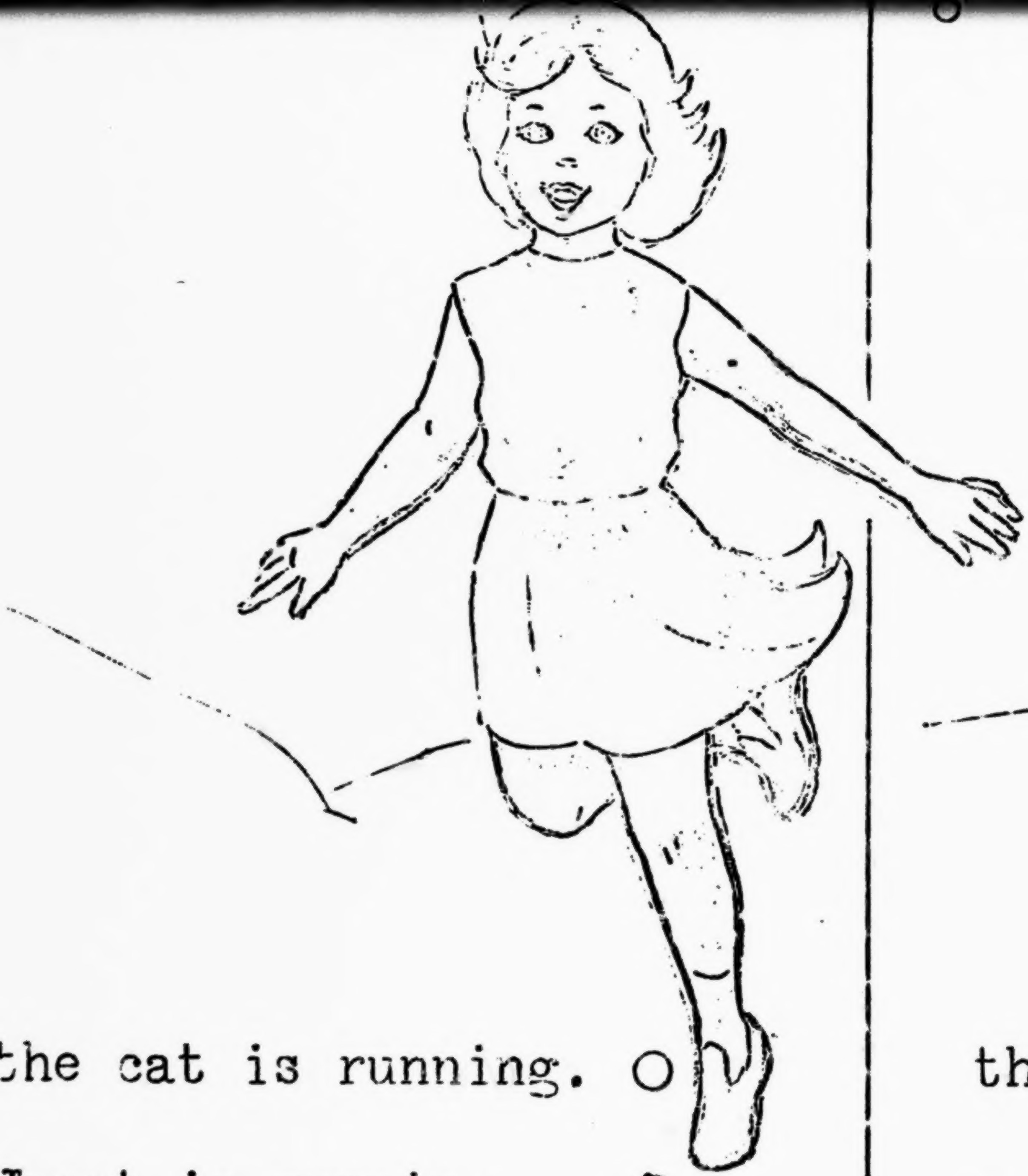


a box ○

blue ○

a cat ○

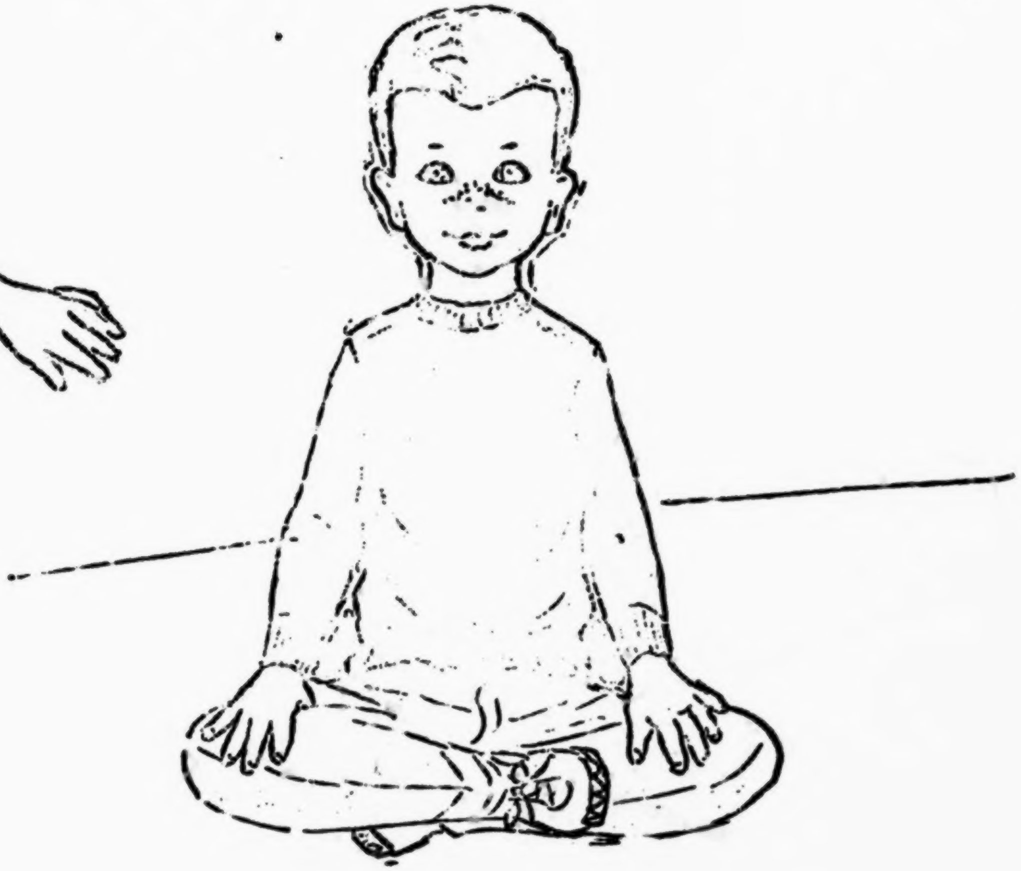
5



the cat is running. ○

Janet is running. ○

a yellow box ○

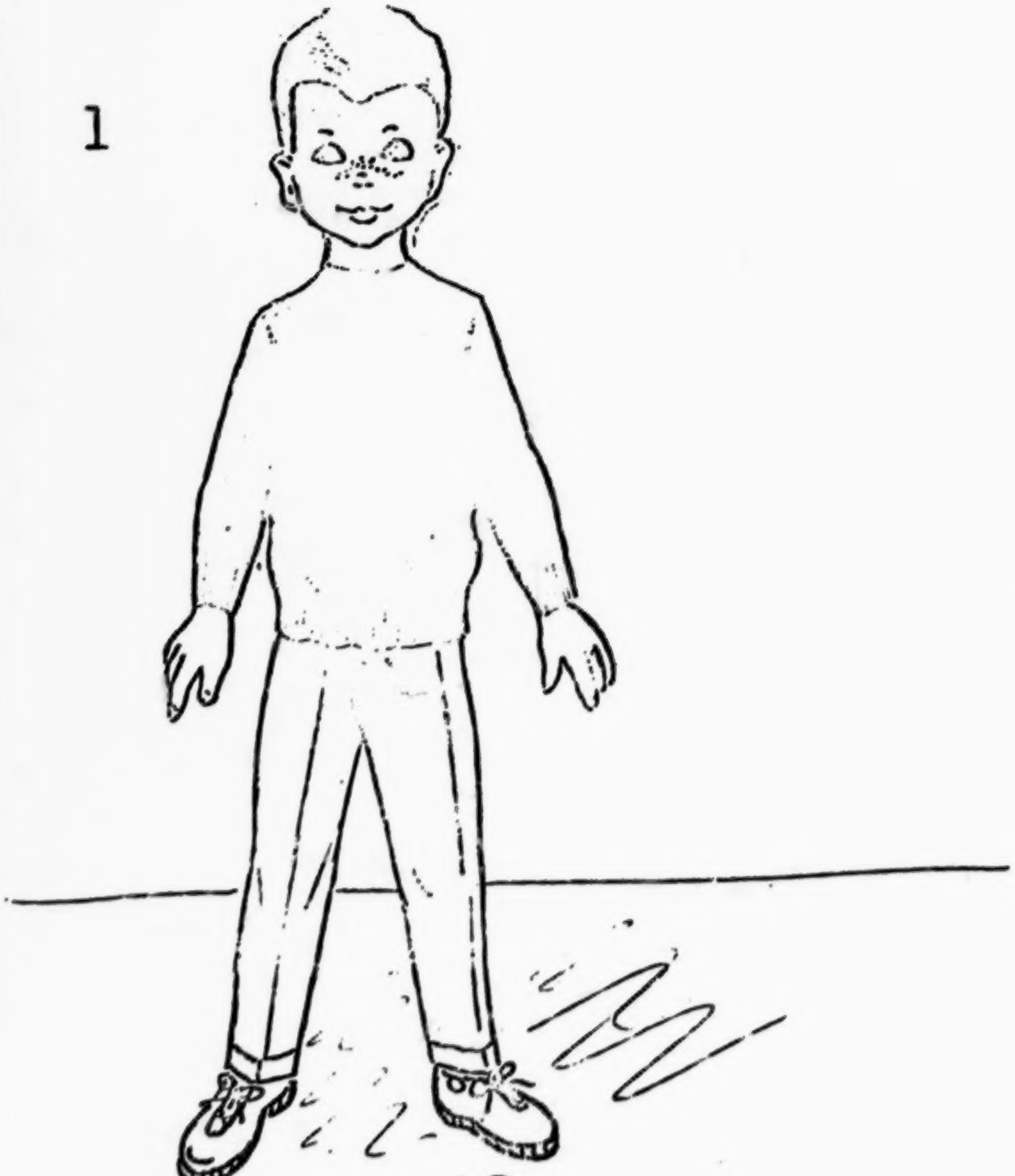


the cat is running. ○

a yellow box ○

Ben is sitting. ○

1

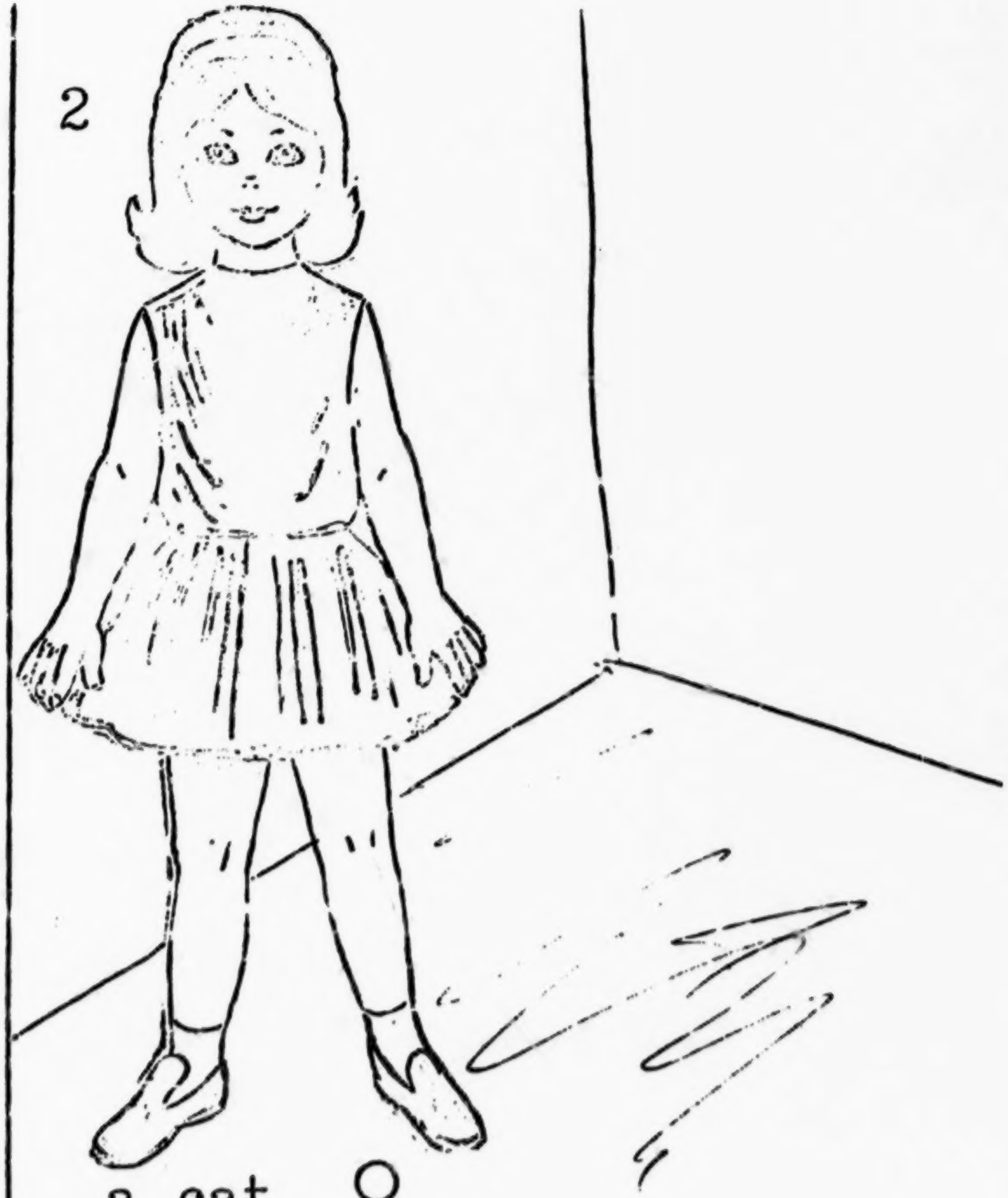


Ben ○

Janet ○

yellow ○

2

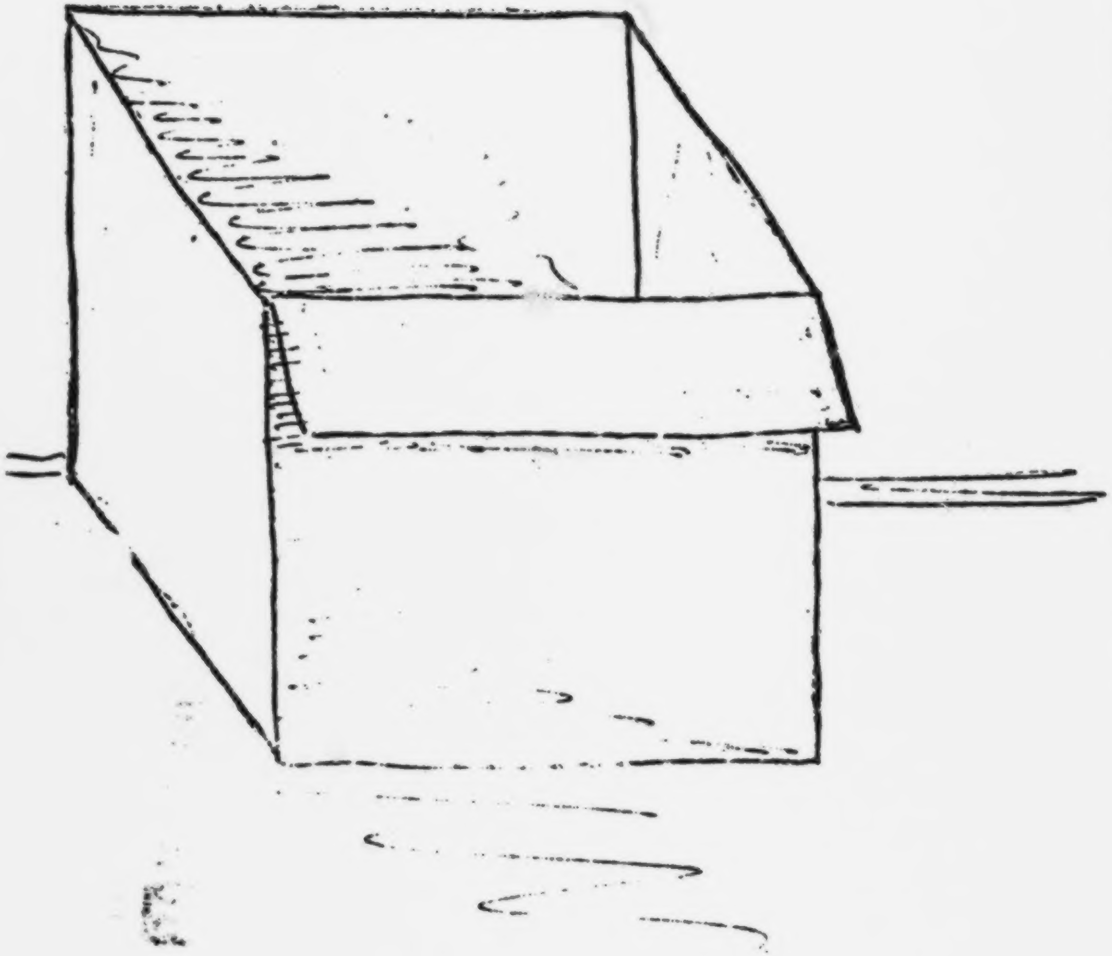


a cat ○

Janet ○

blue ○

25

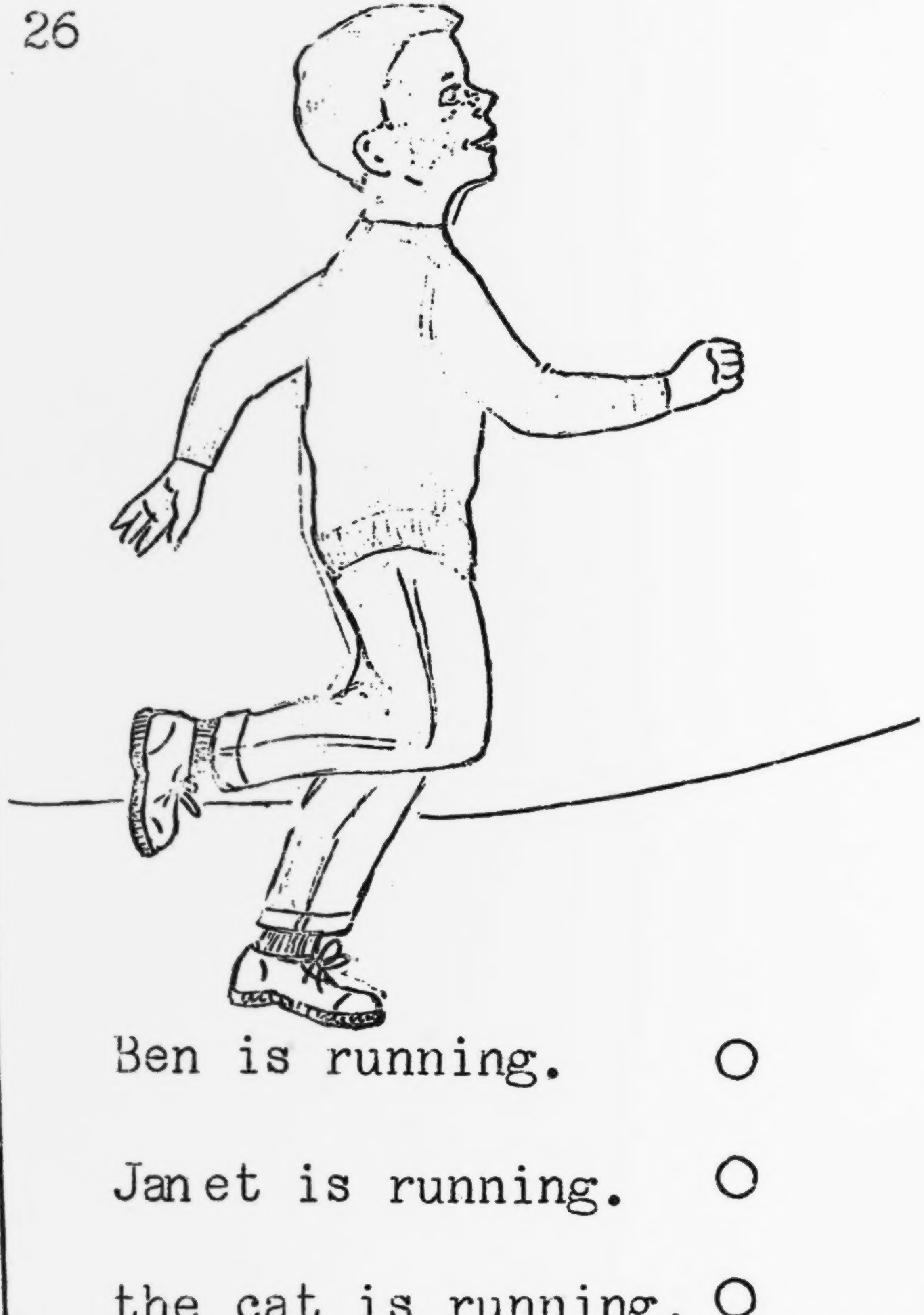


Ben ○

a cat ○

a box ○

26



Ben is running. ○

Janet is running. ○

the cat is running. ○